GEOLOGICAL REPORT

ON

ONDONDERRY,

AND PARTS OF

TYRONE

AND

FERMANAGH.

PORTLOCK.

JA
ANTIQUA
34, UPP

INDEX
to the
ORDNANCE GEOLOGICAL MAPS
OF THE
COUNTY OF LONDONDERRY
and PORTIONS of
TYRONE, FERMANAGH, DONEGAL
and
ARMAGH.

Illustrative of Captn. Portlock's Geological Report

The names of Baronies are shewn, ... thus ___ COLERAINE

Do. .... Parishes, ... thus ___ *BOVEVAGH*

County Boundaries, ------------

Parish Boundaries, ...

Barony Boundaries, ------------

Elevations in feet above Low Water, ___ 125.

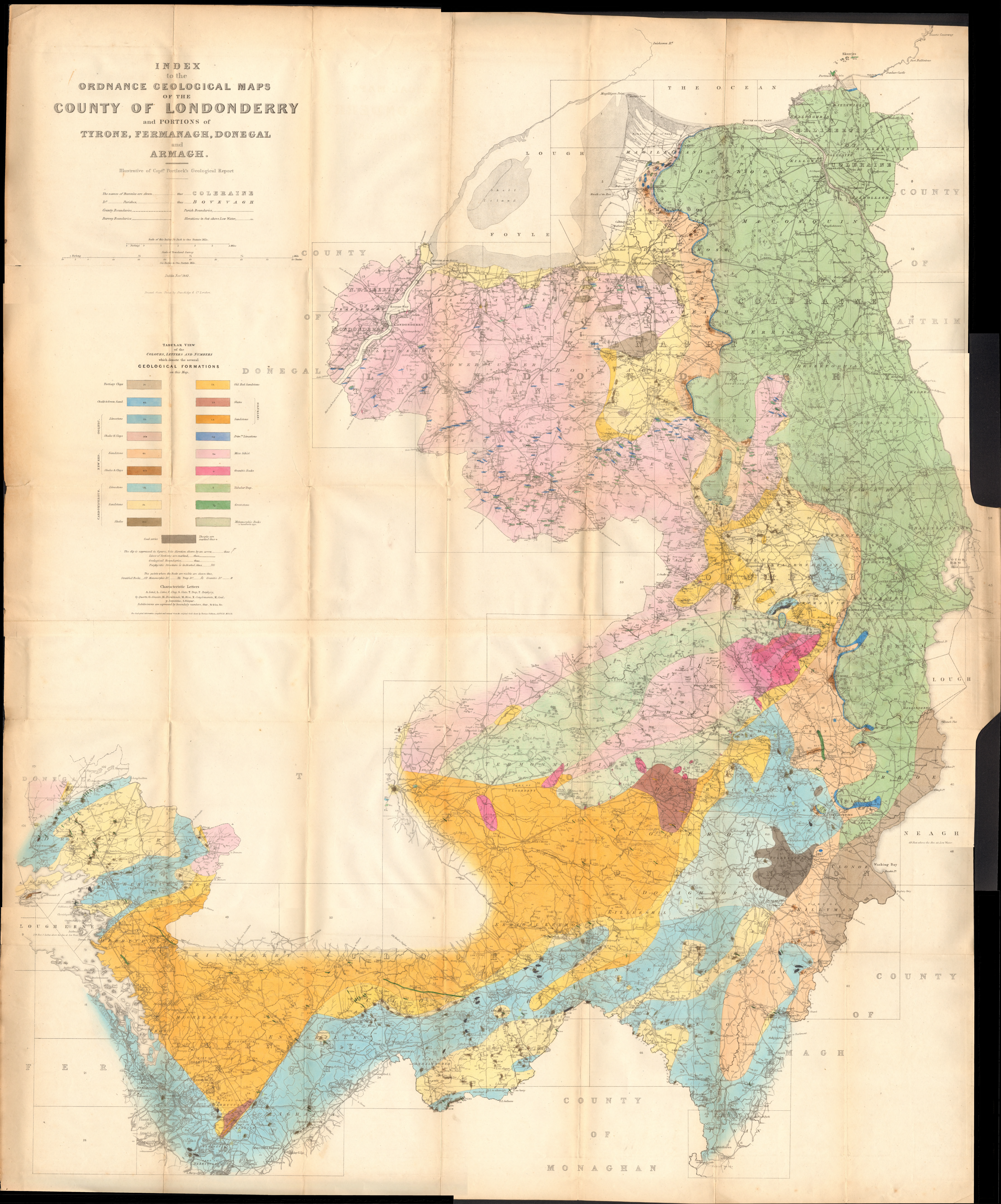
Scale of this Index ½ Inch to One Statute Mile.

Scale of Townland Survey

Six Inches to One Statute Mile.

Dublin Novr. 1842.

Printed from Stone by Standidge & Co. London



TABULAR VIEW
of the
COLOURS, LETTERS AND NUMBERS
which denote the several
GEOLOGICAL FORMATIONS
on this Map.

	Tertiary Clays	7C	2A	Old Red Sandstone	
	Chalk & Green Sand	6L	1S	Slates	SILURIAN:
OOLITIC.	Limestone	5L	1A	Sandstone	
	Shales & Clays	5Cs	Lg	Primve. Limestone	
NEW RED.	Sandstone	4A	Sm	Mica Schist	
	Shales & Clays	4Cs	G	Granitic Rocks	
CARBONIFEROUS.	Limestone	3L	T	Tabular Trap.	
	Sandstone	3A	Tg	Greenstone	
	Shales	3Cs		Metamorphic Rocks (of hornblendic type)	

Coal series ▨ The pits are marked thus ⊖

The dip is expressed in figures, & its direction shewn by an arrow, ______ thus ↗ 20°

Lines of Sections are marked, ___ thus ______

Geological Boundaries, ______ thus ....

Porphyritic Structure is indicated, thus ______ ▦

The points where the Rocks are visible are shewn thus,

Stratified Rocks ___ Metamorphic Do. ___ Trap Do. ___ Granitic Do. ___

Characteristic Letters

A. *Sand*, L. *Lime*, C. *Clay*, S. *Slate*, T. *Trap*, P. *Porphyry*,

Q. *Quartz*, G. *Granite*, H. *Hornblende*, M. *Mica*, X. *Conglomerate*, K. *Coal*,

y. *Serpentine*, f. *Felspar*.

Subdivisions are expressed by Secondary numbers, thus _ T_2 $2A_{12}$ &c.

The Geological information compiled and reduced from the original field sheets by Thomas Oldham, A.B.T.C.D. M.G.S.D.

REPORT

ON THE

GEOLOGY

OF THE COUNTY OF

LONDONDERRY,

AND OF PARTS OF

TYRONE AND FERMANAGH.

EXAMINED AND DESCRIBED UNDER THE AUTHORITY OF THE
MASTER GENERAL AND BOARD OF ORDNANCE.

By J. E. PORTLOCK, F.R.S., F.G.S., M.R.I.A., M.R.D.S., &c.

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OF THE NATURAL HISTORY SOCIETIES OF DUBLIN, BELFAST, AND LONDONDERRY,
CAPTAIN OF ROYAL ENGINEERS CONDUCTING THE GEOLOGICAL BRANCH
OF THE ORDNANCE SURVEY OF IRELAND.

DUBLIN:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE.
PUBLISHED BY ANDREW MILLIKEN, GRAFTON-STREET;
HODGES AND SMITH, COLLEGE-GREEN;
AND
LONGMAN, BROWN, GREEN, AND LONGMANS,
LONDON.

1843.

DUBLIN:
PRINTED BY ALEXANDER THOM, 86 ABBEY-STREET.

PREFACE.

In submitting to the Public, under the authority of the Master General and Board of Ordnance, the first Report made by the geological department of the Ordnance Survey of Ireland, it appears desirable to prefix a few remarks on the origin and progress of that branch of the work. It is unnecessary to dwell on the importance of an accurate knowledge and delineation of the earth's surface, as all practical men are fully aware how indispensably necessary they are to the operations of the engineer and geologist, and how valuable to the geographical naturalist. At the commencement of the Trigonometrical Survey, Colonel Colby, expressing his opinion on this subject to Sir H. Hardinge, then Clerk of the Ordnance, stated, "that the Topographical Survey should be considered a foundation for Statistical, Antiquarian, and Geological Surveys." To him, therefore, must be ascribed the origination of a plan to combine in one great work those distinct elements of research.

To effect this object, as regarded statistical and antiquarian information, no specific arrangements were adopted, although the name-books and journals were calculated to receive and record any valuable matter collected; but in the geological branch, a more definite plan was adopted, and Captain Pringle, R. E., was appointed to superintend it. Under that officer, so eminently fitted, from his tastes and scientific attainments, to conduct the geological inquiries, they had made a most promising beginning, when the necessity of accelerating, and the fear that any collateral inquiry might retard, the progress of the Survey, led to their discontinuance. When subsequently resumed, the spirit which had been at first excited was gone, and the daily increasing demand for "more acres" so pressed upon the officers, that those only who themselves possessed a taste for the subject could be induced to follow it up: Geology had, in fact, been permitted, but not commanded. Nominally I had been appointed to the charge of the work, but no power had been vested in me to enjoin a general geological inquiry, whilst my own time was almost absorbed in carrying forward, first, the prinpal; and, secondly, the secondary Triangulation of the Survey. About the year 1832, the enlightened zeal of Captain Larcom induced Colonel Colby to resume his original project; and, under able instructions drawn up by Captain Larcom, the attention of the officers was more specifically directed to antiquarian and statistical inquiries, and a matured plan adopted for giving publicity to the information obtained.

About the same time, I had commenced the formation of a geological department, and in 1834, I was required to contribute to the projected Memoir of Londonderry, in addition to the Geology, the two sections, Natural History and Productive Economy. Fully estimating the dependence of all branches of natural science upon each other, I entered with pleasure on the researches they required; and, with the sanction of Colonel COLBY, engaged, as Botanist, my late respected and highly valued friend, THOMAS HOPKIRK, LL.D., author of *Flora Glottiana*, and other works; and subsequently, when ill health disabled him from active exertion, Mr. DAVID MOORE, now Curator to the Botanic Garden of the Royal Dublin Society. Additional collectors for Geology were employed, as well as collectors for Zoology, both land and marine; and a department formed for collecting and recording statistical information. Some of the earlier fruits of these varied inquiries appeared in the Memoir of Londonderry, first printed for the British Association Meeting in 1835, and subsequently reprinted and published in 1837. Of that work, had it been continued, I may be permitted to say, that superintended by one possessing so much energy, sagacity, and comprehensive intelligence as Captain LARCOM, and supported by the antiquarian knowledge of Mr. PETRIE, it was calculated, independently of the aid of natural and productive science, to record much valuable information, and to produce an important effect on the public mind.

In 1837 I was enabled, from the advanced state of the works I had been previously conducting, to direct my attention more exclusively to the geological department, then comprising Natural History and Productive Economy; and for this purpose, formed at Belfast, by Colonel COLBY's desire, a geological and statistical office, a museum for geological and zoological specimens, and a laboratory for the examination of soils. It is only from this time, then, that the geological branch of the Survey, in its enlarged form, can be considered an organised work; and all conversant with such subjects will know, that inquiries so extended could not be conducted without much labour both of body and mind, augmented considerably by the form of the Londonderry Memoir, which required parochial descriptions. That none of those inquiries have been fruitless, is also evident from the additions to the British Flora made by Mr. MOORE, and recorded by Sir W. JACKSON HOOKER and Mr. MACKAY, and by several additions to the Irish, and some to the British Fauna, which have been recorded by those distinguished naturalists, Mr. EDWARD FORBES and Mr. WILLIAM THOMPSON.

At the period (1840), when every section of the department was moving forward with a prospect of success, the design of continuing the Londonderry Memoir was abandoned, and the office, museum, and laboratory at Belfast, were in consequence broken up, and everything connected with the department removed to Dublin.

Soon after my own removal, I was directed to prepare for publication all the geological data which had been collected for the County of Derry and Barony of Dungannon, and I entered on the task with a full sense of its difficulty (the district comprising a silurian deposit rich in fossils, the old red sandstone, a portion of the carboniferous strata, the new red sandstone including the trias, the lias, the chalk, and tertiary deposits), and with no desire to go one step beyond the prescribed limits of the district, or to delay the publication for a single day. The more closely, however, I examined the data and the country, the more strongly I felt that geological researches cannot be confined within territorial boundaries, and that it was indispensably necessary to seek those facts in Tyrone (beyond the limits of Dungannon) and in Fermanagh, which were essential as illustrations of the Geology of the district. I would have even wished to go farther, and to have connected the detached carboniferous deposits of Derry and Tyrone with the more highly developed and continuous deposits of western Fermanagh, Leitrim, and Sligo, believing that no just view can be taken of, nor satisfactory subdivisions adopted in, the carboniferous system, until that comparison has been made.

If the work had been originally considered as a whole, and a report required from time to time of such portions only as were deemed satisfactorily determined, no corresponding difficulty would have existed, the work would have been more perfect, and publication more easy; but, hitherto, it has laboured under all the disadvantages of restriction and uncertainty, the field of necessary inquiry being limited, and the minds and energies of those employed depressed; nor has its passage through the press been undisturbed by anxieties and doubts.

In selecting the silurian fossils for more especial illustration, I have been influenced by the principle of fixing the base of the Irish fossiliferous strata, and by a desire to make known a formation previously almost new to Irish Geology, and, though limited in space, rich in the most characteristic fossils of American, European, and British localities. In like manner, I have placed before the public the Irish triasic fossils before unknown, and, of other formations, those which appeared to have a claim on attention from their own interest, or from their bearing on the subdivision of the strata. To this branch of the subject I have been obliged to give my own attention; for although fully sensible of the extreme labour required in investigating fossil Natural History, and the small degree of credit to be acquired in so obscure a subject, I was aware that, if not so undertaken, it must have been left untouched, and my Report have been imperfect and geologically useless.

In respect to the work itself, I have endeavoured to combine the consideration of mineral and fossil characters, and to preserve the mineral distinction of the strata even in the Map; and the present Report may be considered a specimen of a system of inquiry, by which I had hoped to promote the progress of Irish Geology, and to combine with scientific investigation much practical information.

Even before publication, the department has done some service to the cause of Geology, by acting as a pioneer in this northern district to another great geological work, the Map of Mr. GRIFFITH. That able Geologist having, from the Ordnance collection, become acquainted with the silurian deposits of Tyrone and Fermanagh, the fish deposit of Maghera, &c., applied the resources of the public department under his charge to the re-examination of the ground, and employed the former collector of the Survey, Mr. PATRICK DORAN, to revisit the fossil localities and collect specimens for his own work.

To the MASTER GENERAL and Board of Ordnance, and to the INSPECTOR GENERAL of Fortifications, I feel deeply grateful for their forbearance and patience, and for the opportunity they have afforded me of publishing this Report.

I now turn to the gratifying task of acknowledging assistance wherever it has been received. In my own department, I have derived the greatest advantage from the services of my chief assistant, Mr. THOMAS OLDHAM—first in the field, and subsequently during the preparation of this Report. His knowledge of minerals I have freely used in the list of simple minerals, and in the minute examination and description of rocks, and his ability as a draftsman in compiling the Map and Sections; and, I may add, that whenever I have required his aid in any branch of the work, I have found him possessed of the highest intelligence and the most unbounded zeal. Mr. JAMES FLANAGAN has proved, in the geological department, the same honest, industrious, and accurate observer I had known him to be for ten years on the Triangulation; and Mr. PATRICK DORAN I found an excellent collector, whilst he continued with me. Mr. THOMAS DOUGLAS, my clerk, deserves an acknowledgment of his care and industry; and Mr. G. DU NOYER, of the great ability with which he has drawn the fossils and illustrative views. The purely geological department was not large; nor had I any power to augment it, or to direct its exertions to a wider sphere of inquiry.

Of persons not belonging to the department, I shall first mention Captain JONES, M.P., who has contributed to this work the list of Armagh fishes, and most liberally at all times placed his collection and his knowledge at my disposal; but beyond this, he has cheered and supported me by the most encouraging co-operation and kindness, and I cannot too highly value such assistance and friendship. To Dr. Thomson, of Glasgow, the department is indebted for the liberal communication of his analyses of Irish Minerals, and for the aid afforded to my assistant in comparing the Ordnance specimens with his valuable collection; to Professor Jameson, Mr. T. Jameson Torrie, and Mr. A. Rose, Edinburgh, for a similar co-operation; to Mr. Griffith, for his paper on the Annagher Colliery, and to Mr. Edward Sinclair, for his account of the workings of the Lewin Pits; to Dr. Apjohn, for several valuable mineral analyses, and to Dr. Kane, for an analysis of the supposed Bronzite of Portrush, and an excellent analytical paper on Mineral Springs; to Mr. J. Bryce, Jun., and Mr. G. Hyndman, for their paper on the tertiary deposit recently discovered near Belfast; to Major Austin, for the loan of his Waterford silurian fossils; nor should I omit the obliging attention of Mr. Murchison in sending me a copy of his great work on the Silurian System prior to its publication; the donation of fossils from Berwick by the Rev. Mr. Jenkinson, of Lowick; and the kindness of the Council of the Geological Society, in placing their collection of Tribolites at my disposal. Let me add my thanks to Captain Larcom for having allowed, with the sanction of Colonel Colby, the Map which accompanies this Report, to be engraved for the Stationery Office, by the Ordnance Survey engravers; and to the Comptroller and Officers of Her Majesty's Stationery Office for the satisfactory manner in which they have forwarded the publication.

Had the work been continued as at first projected, and the botanical and zoological catalogues also published, I should have had to acknowledge the assistance of Dr. Hopkirk and Mr. David Moore of the department; as well as the aid of those eminent naturalists, Mr. William Thompson and Mr. Robert Ball, and of Mr. Haliday, the distinguished entomologist, who had undertaken to contribute to the work a catalogue of Irish insects.

I now, then, submit this Report to the Public, conscious that my own exertions and those of the little band of my fellow labourers have been cheerfully and unremittingly devoted to the object of rendering the work deserving of public sanction and support.

January, 1843.

TABLE OF CONTENTS.

CHAPTER I.

Introductory Remarks.

COLOURING—GEOLOGICAL DIVISIONS—SIGNS.

Introduction.—Physical features of the earth's surface, 1. Influence of mountains and plains on the progress of man, 2. Variety of composition, 3. Pursuit of inquiry as to origin of diversified appearances, 3. Errors of ancient writers, 4. Perception of different formations, 4. Arrangement and order of strata, and means of identification, 5. Organic remains as elements of geological reasoning, 6. Principles of comparison and deduction in geology, 7, 8. Modes of representing geological appearances, by colours and signs, 8. Difficulties of indicating geological formations, 8. Various modes adopted, 8—12. Granites, 13. Crystalline schists, metamorphoses in rocks, 14. Limestone, 15. General results, 15—19. System of colours adopted, explained, 20. Other signs adopted, explained, 21.

CHAPTER II.

Review of the Works of preceding Writers.

Archbishop King (1708); Derry and Donegal, shells, tertiary deposits, 22. Anthologia Hibernica (1794), Bishop Nicholson (1725); Rev. Robert Innes (1732); natural history of Magilligan parish, rich soil, 23. Diluvial effects; representation of Merog rock, or Finger-stone, 25. Benyevenagh, undercliff, representation of it, 26. John Whitehurst (1786) on counties of Armagh, Antrim, Tyrone, 27. Portrush, Causeway, 29. Rev. William Hamilton (1790) on the northern counties, 30. Volcanic origin of basalts; Causeway, &c. 30. Basaltic formations, 32. Extensive chalk formation, 33. Rev. William Richardson (1808) on alterations in the structures of rocks in Derry and Antrim, 34. Chalk, &c., 37. Arguments of the aqueous and volcanic theories (1799), Kirwan, Richardson, 37. Kirwan (1802) on the proofs of the Huttonian theory; basaltic formations, Richardson, 38. Playfair (1802) on the aqueous formation of basaltic rocks, 39. Richardson (1804) on volcanic theory, 40. Rev. W. Conybeare and Rev. W. Buckland on the indurated strata of Portrush, 40. James Bryce (1834) on the rocks of Portrush, 41. Mr. Griffith (1835) on the foregoing, 43. Richardson (1812) on ochre beds, 44. Successive steps of formation, 45. Mr. Abraham Mills (1790) on strata, and volcanic appearances of North of Ireland and Western Islands of Scotland, 45. Rev. George V. Sampson (1814) on the chart and survey of Londonderry, 46. Primitive rocks, 46. Secondary rocks, 47. Basaltic formation, 49. Doctor J. F. Berger and Rev. W. Conybeare (1816) on the north-eastern counties, 50. Differences between the Down and Derry mountains, 50. Comparison between the geological structure of Scotland and Ireland, 51. Granite, 52. Syenite, 52. Mica schist, &c., 53. Flœtz rocks, 54. Lias, 55. Chalk, 56. Trap, 57. Mr. Griffith (1829) on the coal districts of Tyrone and Antrim, 59. Varieties of formation, 59. Limestone country, 60. Sandstones, 62. Mr. Griffith's geological map described, 63—77, 81. His reports, 64. Summary of his views, 77. Mr. James Bryce (1832) on geological structure of north-eastern part of Antrim, 78. Sandstones, &c., 78. Coal formation, 80.

CHAPTER III.

Physical Features.

Variations of surface, 83. Diversity of formations, 84. Mountain ridges, 84. Basaltic range, 85. Present condition and progressive modifications of surface, 85, 86. Effect of geological formation on road-making, 86: on commercial prosperity, 87: on agricultural cultivation, 88. Comparison of Derry, Coleraine, and Belfast, in these respects, 87—89. Influence on climate, and importance of local registries of weather, 89.

CHAPTER IV.

Strata underlying the Basalt, from the Chalk to the New Red Sandstone, inclusive.

Order in which the strata are considered, 90. Overlying trap rocks and secondary strata, 91. Chalk; conglomerates, 91. Features of the chalk, and contact with other strata, 92. Masses of basalt imbedded in chalk, 93. How accounted for, 94, 96. Dip and irregular surface of chalk strata, 95. Picturesque formation of White Rocks, 96. Remarks on Portrush and Fair Head, 97. Position of metamorphosed organic strata, 98. Igneous rocks, 99. Fossils, 99. Portrush and Down Hill; as to secondary strata, 101. Changes in the chalk, 102. Caves, 102. Magilligan to the Keady, Benyevenagh, basalt, 103. Pinnacles and landslips, 104. Sandstone, &c., 104. System of calcareous grits and marls, 105. Marls indurated by metamorphic action, 105. White grits and other beds, 106. Shales, 107. Clays, 107. Succession of strata, 107, 108. Stratification of Benyevenagh, and causes of dislocations, 109. Keady to Donald's Hill; chalk and basalt, 110. Chalk bays, 111. Benbradagh to Eden; igneous action, 111. Flints, &c., 112. Craignashoke; stratification, slips, 113. Chalk formation of Slieve Gallion Carn, 113. Tamlaght; trap-dyke cutting through chalk, 114. Peculiar deposit, the result of chemical change; and analysis of it, 115. Alternations of chalk, &c., 116. Results of phenomena observed, 116. Analyses of substances found, 117, 140. Account of lias district, and enumeration of fossils found therein, 118—140.

CHAPTER V.

Basalt.

Course of the great basalt formation, west and east, 141. Appearances of, 141. Changes it has undergone, 141. Constitution of the basaltic mass, 141. Sections of it, at Down Hill, 142; Umbra and Woodtown, 142; Carnowry, Rock Head, 142; Benyevenagh, 143. Deductions as to the formation and character of the basaltic rocks, 146. Various structures of basaltic beds, and analogous formations at different places, 146. Massive basalt in superposition upon prismatic, at Craigahulliar; woodcut, 147. Epochs of basaltic formations, 147. Mode of deposition of the beds, and results of aqueous action prior to basaltic flows, 148. Course of the basalt; White Rocks, Dunluce, Down Hill, &c., and beds in contact with it, 149. Metamorphic condition of some of its beds illustrated, 150. Detailed examination of the mineral structure of the basalt, as compared with the augite rock and altered lias of Portrush, 150—155. Conclusions; dykes, metamorphic alterations, 155. Elevations of basaltic mountains, 156. *Addendum*—Artrea dyke, App. 741.

CHAPTER VI.

Tertiary—Calcareous Clays.

Tertiary strata in Derry, 157. Shells found therein, 157. Localities and features of the calcareous clays, 157—160. Other clays, 160; and account of shells found therein, 161, 162. Connection of, with shell banks of Lough Foyle, 163. Extent of shell deposit, and its value shown, 164. Clays and sands of Lough Neagh and Lough Beg, 165. Shell beds of Myroe, &c., 165. Great value of these deposits in agriculture, 166. *Addenda*—Tertiary deposit near Belfast, App. 737, 738. Shell marl, App. 740. Slob, App. 740.

CHAPTER VII.

Crystalline Schists—Gneiss—Mica Schist—Hornblendic Schist.

Character and history of these rocks, 168. Course and localities of, 169. Their composition and epochs, 170. Hornblendic rocks, 171. Alternations of rocks, 172. Ochres, 173. Analysis of ochres, 174. Their uses, 174. Limestone, 175. Wear and dislocations of strata, 176. Specimens found in the schistose strata, their variety and arrangement, 177. Particulars of, detailed, 178—204.

CHAPTER VIII.

Simple Minerals.

Their arrangement, &c., remarks, 205. Detailed list of the respective minerals, their characters, localities, &c., 206—227. *Addenda*—Analyses by Doctor Thomson, App. 742—745. Analysis by Doctor Kane, 742.

CHAPTER IX.

Silurian Strata.—Descriptive list of Fossils.

History and interest of these strata, 228. Description of, and localities, 229—232. Arrangement of organic remains, 230. Geological importance of these deposits; their fossils, &c., 233. Trilobites, description, affinities, &c. of, 234—254. Descriptive list of fossils found in the silurian, carboniferous, oolitic, and cretaceous strata, 254—476. Tabular summary of silurian fossils, described, 476.

CHAPTER X.

Old Red Sandstone, and New Red Sandstone.

Difficulty of defining the distinction between these formations, 477. As to designations of these and other geological formations, 478. Alternation of sandstones with other formations, 479. Nature of difficulties in geologically separating the sandstones, 480. Fossils, 481. Connection with carboniferous strata, 482. Course and localities of the sandstones, 483. Description of the sandstone beds, and relations to other strata, 488. Evidences of metamorphic change, 493, 494. Porphyry, 493, 494. Line of the old red sandstone, 495. New red sandstone, 498. Conglomerate, 501. Remarks on formations connected with the sandstones, 501—506. *Addendum*—Artrea dyke, App. 741.

CHAPTER XI.

Igneous and Metamorphic Rocks.

Great interest of these rocks, 507. Their intimate connection, 507. Origin and character of, 507. Granite, 508. Schists, 508. General views of metamorphosis, 508. Dykes, causes and effects of their action, 509. Passage of rocks from sandstones into crystalline formations, 513. Illustrations of metamor-

phosis, 515. Granite, and hornblendic rocks, 518. Speculations as to the granite, 520. Quartz, 522. Porphyritic formations, 523. Trap, 523. Varieties of igneous rocks in the district, examined, 524. Forms of modification in secondary strata, 529. Schists, &c. examined in detail, 530. Granites of Slieve Gallion, 550. Evidences of metamorphosis in the hornblendic rocks, 555. Probable epochs of changes and phenomena, 557.

CHAPTER XII.

Carboniferous Strata.

Classification and relations of these beds, 560. Shales, and their fossils, 561. Limestone district; contrast of the east and west, 562. Appearances of the country, and physical features of the strata, 563. Fossils, 564. Series of alternating beds, 565, 566. Fossils therein, 567. Carboniferous group, with silurian fossils, &c., 568. Shaly deposit, and new fossil therein, 569. Shales and their fossils, 570. Epochs of deposits, 572. Succession of beds in different places shown, 574, 575, 576. Mountain limestones, 578. Succession of beds, 579. Fossils, 580. Sections of beds, 582, 583, 585. Dips and order of strata, 587. Relations of isolated limestones to calcareous grits, 592. Results of the review of the shales, 596. Carboniferous grits, 596. Identification of limestones in different localities, 597. Descriptive account of the collieries of Tyrone, 599—629. *Addendum*— Fossils, App. 745.

CHAPTER XIII.

Detritus.

Difficulties connected with deposits of sand and gravel, &c., 630. Agencies of boulders and gravel, 630. Account of various localities, and examples of boulders, 631. Sand and gravel, 632—637. Variety of arrangement in detritic beds, 633. Deductions as to the detritic deposits, 638. General notice of detritic localities, 639. Conclusions, 640. *Note*—Glenullin detritic vale, or ancient lacustrine bed, App. 746. Tables of gravels, Derry, Tyrone, &c. App. 747, 748.

ECONOMIC GEOLOGY.

No. I.—*Mineral Springs*, 641. Report on mineral waters, 642. Analyses, 644. Temperature, 648.

No. II.—*Climate—Drainage*, 649. Tables of observations, &c., 650—669.

No. III.—*Mineral Statistics*, 670. Tables of quarries, 672—675. Lime, 676. Clay, tiles, &c., 680. Potteries, 682. Tables; bricks, tiles, 683, 684. Coal, 685. Iron pyrites, extraction of sulphur, 685.

No. IV.—*Soils*, 688. Table of composition of soils in Londonderry, 689.

No. V.—*Cultivation*, 690. Tables, as to Londonderry: sizes of farms, 693. Rotation of crops, 694. Proportions of crops, 696. Average cost per acre, 698. Modes of improvement, 699. Manufacture of cheese by associations, 701. London companies, 708. Orchards, 709.

No. VI.—*Agricultural Schools*, 710. Templemoyle Seminary, 710. Horticultural schools; London companies, 734.

APPENDIX.

Addenda to Chapter VI.—Tertiary deposit near Belfast, 737, 738. Shell marl, 740. Slob, 740.

Addendum to Chapters V. and X.—Artrea dyke, 741.

Addendum to Chapter VIII.—Simple minerals, and analyses by Doctor Thomson and Doctor Kane, 741.
Addendum to Chapter XII.—Fossils, 745.
Note on Chapter XIII. Glenullin detritic vale, or ancient lake, 746. Tables of gravel, showing their probable origin, Derry, 747. Tyrone, &c., 748.
Fossils: list and explanation of, 749. Synoptical table of, 750—769.
INDEX, 771.

LIST OF WOODCUT ILLUSTRATIONS.

Page
1. The Merog, Merrick, or Finger-stone, a pillar-like fragment of basalt, formed of parts of several distinct beds, standing high up on the face of the basaltic cliff, 25
2. Benyevenagh, undercliff from subsidence of the basalt by pressing out the lias clays, 26
3. White Rocks, near Portrush, showing the wear at successive heights, . 90
4. Do. remarkable crater-like chasm, the basalt descending below the level of the chalk: this is behind the "wishing arch," . . . 92
5. Do. large lump of basalt immersed in the chalk, twenty-five feet above the sea line, ... 93
6. Another immersed lump, at sea level, with traces of disturbing action on the chalk, 94
7. Do. Fissure in the chalk; at the top closed by basalt which probably once filled the whole chasm, ... 95
8. Do. Arches worn into the chalk by the constant action of the waves 96
9. Portrush, veins in the altered lias, ... 100
10. View of Portrush from the west strand; the small western pier is in shade; the long pier and the houses near it are in light, the masts of the ships showing the position of the harbour; the great basaltic promontory and the principal line of houses appear in shadow behind it, ... 101
11. Benyevenagh, slips from subsidence of the basalt; the underlying lias clays, and new red marls being squeezed out by the pressure of the superincumbent mass, 103
12. Pinnacle of basalt, formed of portions of successive beds, remaining as an isolated pillar high up on the face of the basaltic cliff of Benyevenagh, . . 104
13. Dyke, called Lady O'Cahan's Bridge, east view, . . . 105
14. Do. do. west view, . . . 106
15. Castle Rock, face of Benyevenagh, immense slips of the basalt from subsidence, 110
16. Craignashoke, slip of the [illegible] 113
17. Fossil, [illegible] 137
18. [illegible], inland basaltic façade supporting a mass of amorphous basalt which divides into large angular fragments, ... 147
19. Pot of Legananuim, remarkable excavation in the trap, *not* in proportion to the probable effect of any present water action, . . . 148
20. Ness waterfall on the Burntollet River, parish of Lower Cumber; the river flows through a chasm in the mica schist, partly due to wear and partly, it is probable, to dislocation, ... 168
21. Alternating indurated schists and hornblendic rocks. The hardened schists resist the action of the water and project in broken crests above the water of the Faughan, parish of Clondermot, ... 172
22, 23. Two views of an ancient river-course in the mica schist, now ten feet above the level of the Burntollet 176, 177
24. Bannagh River, north of Kesh, County of Fermanagh. The river falls in successive steps over tabular beds of shale. This shale is probably higher geologically than the shales with Modiolæ lower down the river, but a line of division could only be drawn arbitrarily at this locality, . . . 595
Diagram showing the air courses in the Lewin Colliery, ... 622
25. The Bin, near Claudy, an excavation or chasm forming a small glen or ravine in a deep deposit of laminated sand with fine partings of clay, . . 637
26. Section showing the position of a tertiary deposit, near Belfast, . . 738

DESCRIPTIVE LIST OF ILLUSTRATIONS.

MAP.

THE Townland Survey of Ireland is published by counties, and in sheets, each of which is 3 feet long, and 2 feet wide, containing an area of 24 square miles, or 15.360 acres, the scale being 6 inches to a statute mile. The sheets are numbered consecutively, from W. to E., and from N. to S. The present Map has been compiled from the large maps, the rectangular numbered spaces representing the sheets; and as several counties are here combined together, there are several series of numbers, each of which corresponds to the sheets of the particular county within the boundary of which it occurs. For the characteristic marks of the various boundaries, see the Map. *The Geological Principles* of the Map have been explained in Chapter I. The mineral type is shown by colours and by letters; the colour being applied generally, the letter to the actual locality;—thus all limestones are represented by blues and by the letter L; all sandstones by yellow and the letter A (Arena); all clays and shales by browns and C; ordinary slates a shade of brown with the letter S; granite by red and the letter G; granite compounds by red and G. with an exponential letter, as Gh. syenite, or hornblendic-granite; schists of a granitic type red, with the letter S and proper exponents, as Sm. mica schist, Sm.q. mica schist passing into quartz-schist, Sm.g. mica-schist passing into granite, &c. Basalts, greenstones, and all rocks of a hornblendic type, green, and by the letter T, trap, as T^1 basalt, T^2 amygdaloid; or H, hornblende, with the necessary exponents; Tg. represents greenstone, as being allied to the hypogene rocks. Q. signifies quartz; K .coal; and when any of these letters are applied exponentially or adjectively, the small character is used, as Gq. [illegible]-granite; X. signifies conglomerates. In applying letters to distinctly metamorphic rocks, the same characters are used for both, to indicate that there is here either a passage of the one into the other, or such a combination of their respective characters as to make it doubtful whether the one rock has not resulted from a metamorphic change of the other: thus, GA. signifies a granite with traces of an arenaceous structure; SG. and GS. rocks which in mineral structure are intermediate between granite and schist, the letter of the class to which they approximate nearest being placed first; H.Gh. a syenitic hornblende rock; HG. hornblende rock assuming a granitic structure; HTg. a greenstone-like hornblende rock; HS. a slaty do., the large S being here retained to preserve the metamorphic principle; and supposing the schistose character predominates, S takes the lead, as SH. slate which has passed into a hornblende rock, or a hornblende slate; STg. greenstone slate; SGh. a syenitic slate, &c. Any of the letters used in capitals as characteristics of classes, become when small, exponential or adjective.—L. limestone. l. calcareous; A. sandstone or sand, a. sandy or gritty; C. clay, c. clayey; X. conglomerate. x. conglomeratic; though in general the two characters Ax. are combined together to signify conglomerate; S. slate, s. slaty, as Cs. slaty clay or shale; Y. serpentine, y. serpentinous; P. porphyry, p. porphyritic, D. detritus, d. detritic; ϕ (on the Map f.) felspathic.

Geological Formations are expressed by figures, commencing by the first fossiliferous formation—1. Silurian, 2. Old Red Sandstone, or Devonian, 3. Carboniferous, 4. New Red Sandstone, or Poikilitic and Triasic, 5. Oolitic or Liasic, 6. Cretaceous, 7. Tertiary. Subdivisions, by small or exponential figures, as 1^1 or 1^1, lowest division of the Silurian, although in the limited silurian deposit of this Map it has not been attempted to [illegible] the formation as the majority of fossils belong to the Llandeilo flags and Caradoc [illegible]. 2^1 2^2, first and second divisions of the Devonian. 3^1 3^2 3^3 3^4, first, second, third, and fourth, divisions of the Carboniferous. 4^1, New Red Sandstone. 4^2 Trias, not however shown on the Map. 5. Oolitic or Liasic. 6^1 6^2 6^3, Greensand, Lower Chalk, and Upper Chalk, not divided on the Map, as the space even where a satisfactory division could be effected would not admit of representing it. On the Map the mineral letter, and the formation and [illegible] figures are combined, as 1S. silurian schist; 2Ax. old red conglomerate; 3Cs. [illegible] shale of the carboniferous system: $3L^2$ limestone of the second carboniferous section, or first great mountain limestone: $3A^3$ grits of the third carboniferous section; $3L^4$ limestone of the fourth carboniferous section, or upper mountain limestone. And by the use of these simple colours, letters, and figures, the general mineral and physical characters of the deposits, the geological positions, and the actual localities are represented on a map even of the small scale of the present, with nearly the same facility as on the Townland Maps, to the sheets of which reference is made in the Report, the small Map being only an index to the large. Clays, either highly calcareous and with pebbles, similar to those of the tertiary deposits, but without fossils; or highly developed though not calcareous, such as the clays and slob along Lough Foyle, the Bann, &c., could not be coloured without obscuring the geological formations,—they are marked out along the southern shore of Lough Foyle, the banks of the Bann showing the river flats, and in several detached spots of Derry, by lines of small stars or crosses, easily distinguished from the boundaries of formations.

SECTIONS AND VIEWS.

In the sections, which have been accurately laid down from the original plans, the same scale is invariably used for heights and distances. The scale adopted is either equal to that of the Townland Maps, namely, six inches to the statute mile, or an inch to 880 feet; or when expressly so stated, to half that scale, or 3 inches to the mile, or an inch to 1760 feet. The lines of section have been directed as nearly as possible in the line of dip of the strata to be illustrated; but as, in nature, numerous local variations occur, the following method of representing the actual arrangement of the strata in respect to the section line has been adopted:—Parallel to and below the sea-level line or base line of altitude is drawn a line which represents the line of section, the bearing of which is shown by a line on the Map, and arrows are drawn showing the amount and direction of the dip of the rocks relatively to the line of section. On the sections the apparent dip is represented, the actual dip being reduced by calculation to that shown by the intersecting plane: if, therefore, the section is in the line of strike, the strata are represented horizontal; but the erroneous impression is at once rectified by the arrows or diagram underneath. The colours used on the Map are also used in the sections, but the larger scale of the latter admits of much more detail. This will be understood and the use of the sections facilitated by remembering that in the sections on the larger scale, or six inches to the mile, every distance on the small Map is multiplied twelve times, or represented by a distance twelve times as long; and in the sections on the smaller scale, by a distance six times as long.

PLATE A.

FIG. 1.—Section from Lough Foyle across the extensive flat of Magilligan sands to the basaltic escarpment. This shows a repetition of strata, resulting from a double slip. The probable true position of the chalk, lias clays, &c., is calculated from the ascertained thickness of the trap rocks at adjoining points; and in passing down towards the flat, the repetition of strata and the probable mode of its occurrence is shown. The Magilligan sands consist of undulating hills of fine sand, frequently resting on bog, below which is gravel. The great base-line on which the Ordnance Survey of Ireland is founded, was measured on this flat in 1827.

FIG. 2.—Section of Benyevenagh Mountain, showing the manner in which an immense mass of the basaltic rock has slipped, by outpressing the softer secondary strata beneath. The remarkable outline which the hill thus acquires is seen in Plate B., and the woodcuts 11 and 15, Chapter IV.

FIG. 3.—Section from Newtown Limavady to Stradreagh, showing the succession of the strata from the mica schist to the chalk and basalt. The position of the remarkable triasic beds abounding with Muschelkalk fossils, and occurring between the more marked new red sandstone and oolitic strata is shown to the left of the section. They are slightly magnified in thickness in order to make them distinct.

Fig. 4.—Section across the sandstone district of Dungiven and Bovevagh. The conformable continuity of the strata from the old red to the chalk is well shown in the section. To the very coarse conglomerate of the old red succeeds a series of sandstones, clays, and impure nodular limestones, irregularly developed; false or transverse bedding is common in the sandstones: resting on these are the tertiary Nucula clays. Higher in the section the sandstones are more developed, become softer, with traces of plants, &c., and pass upwards into the red and variegated beds of the new red. In the uppermost and marly beds, the Posidonomya *minuta* is abundant. To these succeed the lower members of the chalk, mulatto and chalk-marl, and then chalk, capped by layers of amygdaloid and basalt.

Plate B.

This view, taken from the Standing Stone, near Dungiven old church, gives a distinct representation of the headlands of the great western escarpment of the basaltic area. The foreground and middle distance show the *wavy* flat of the carboniferous sandstones and shales passing upwards to the new red, which forms the slope of the hills, while the line of the chalk is marked by the bottom of the precipitous façade of the overlying trap. The bay-like form of the outline, and the character of inland cliffs and headlands assumed by the projecting hills, are obvious. To the left of the plate the remarkable outline which the slips have given to Benyevenagh is seen. The trees to the left of the section mark the entrance to the village of Dungiven; and those to the right of the section in shade, at the base of the hill, mark the Hass, where the scales of Holoptychius, &c., have been noticed (page 577). The face of Benbradagh, to the right of the section, is represented somewhat too precipitous.

Plate C.

On this plate is given, a series of sectional views, exhibiting the phenomena of dykes, contortions, faults, &c.

Fig. 1.—Shows the appearances at the remarkable dyke which passes through the chalk at Coagh, parish of Tamlaght. See page 114.

Fig. 2.—A curious contortion of the strata of the new red in Curley Burn, parish of Drumachose; the beauty of this is, in nature, heightened by the varied red, purple, green, and light coloured tints of the marly clays and sandstones.

Fig. 3.—Is an example of the remarkable manner in which the sandstones rest unconformably on the mica schist in the north of Derry, along Lough Foyle.

Fig. 4.—Is an anticlinal break in the sandstones of the same district.

Fig. 5.—Is a fault in the sandstones of Dungiven district. This appears to be due to the yielding of the softer beds, and the view shows the manner in which the shale beds are bent or squeezed upwards along the fissure. Many faults are probably due to the same cause on a larger scale.

Fig. 6.—On the banks of the River Roe, near Dungiven; it shows a very interesting and complicated disturbance in the carboniferous sandstones and shales. The oblique bedding of the sandstones is remarkable.

Figs. 7, 8, 9, 10.—Are examples of the irregular deposits of shales, grits, and impure limestones in Altmover Glen, near Dungiven. Compare these with the views of detritic deposits in Plate I.

Figs. 11, 12, 13, 14, 15, 16, 17, 18.—Are all representations of the many forms in which breaks, dislocations, slips, and faults occur in the shale and grit deposits of Ballynascreen parish. These are the shales abounding in Modiolæ, &c. (Page 514).

Fig. 19.—A fine example of false or transverse bedding in the upper portion of the new red sandstone, near Moneymore.

Fig. 20.—A double break or fault in the conglomerates and thin-bedded sandstones of the old red (see Plate E., fig. 3), near Slieve Gallion: a trap dyke is visible near this.

Fig. 21.—Is another instance of the complicated nature of the grit and shale beds on the Altagowan, parish of Ballynascreen—(page 575).

Fig. 22.—A trap dyke near Moneymore—see detailed description, (page 511).

PLATE D.

The upper view on the plate, taken from about one mile east of Draperstown or Ballynascreen, will give some idea of the lake-like expansion of the vale. On the left in the distance are the mica schist hills of Doan and Spelhough, with their rounded outlines; the latter cut into by the remarkable chasm called Spelhough Gap (page 176). Between these and the basaltic capped hill Craignashoke is seen the depression, along which the sandstones stretch across the dividing ridge into Dungiven (see Map, Sheets 31, 35), while they pass in a similar manner between it and Coolnasillagh on the other side. Through the undulating flats in the foreground the Moyola winds its course.

The lower figure gives a more general view of the same vale, the same waving character is seen in the lower grounds, due in part to the detrital covering, and in part to the broken nature of the strata. To the left of the view is Slieve Gallion Carn, with its basaltic cap, resting on the chalk and new red strata, and once continuous with the similar hill of Craignashoke on the opposite side of the vale. The carboniferous limestone summit of Cullion is seen next to it, and the relative heights and connections of this deposit, with that at Desertmartin, to the right of the view, will be understood by a comparison of this view and the Map (Sheet 41, County Derry). Between Cullion and Slieve Doan the entrance to the bay-like valley, in which the old red sandstone stretches up to Ballynascreen old church, is seen. To the right of the view, and above the rounded mica schist range of Coolnasillagh, &c., the basaltic knoll of Carntogher is seen in the distance (see Chaps. IV. V. VII. XI. XII.)

PLATE E.

FIG. 1.—Section through Corick Hill, parish of Dungiven, showing the deposition of the sandstones on the mica schist, which rise to view on either side. Resting on the mica schist, a small patch of coarse conglomerates, probably belonging to the old red series, occurs, though in the actual line of section concealed by detritus, which also covers the rocks for a considerable height on the hill. Grits of the carboniferous series then appear, which, passing under the basaltic cap of Corick, are again seen in the valley of Glenshane. The marly sandstones and marls of the new red, with slight traces of the chalk, are capped by the tabular trap (see page 112 and Plate F., fig. 2).

FIG. 2.—Shows a similar capping of the carboniferous sandstones by the basalt of Craignashoke. The carboniferous strata, though in the line of section here shown they appear tolerably regular, are in this district remarkably confused and broken up by internal disturbance (see page 113 and Plate F., fig. 2).

FIG. 3.—Is a section from the basaltic cap of Slieve Gallion Carn to the general escarpment of the basaltic area. The enormous amount of denudation which has taken place, if these were once continuous, is shown by the dotted line. The dip of the chalk, as well as can be ascertained, nearly corresponds at both extremities of the section.

FIGS. 4, 5.—These sections studied in connection with the Map and Chap. XI. will illustrate the remarkable geological structure of Slieve Gallion.

FIG. 6.—Exhibits the succession of the strata in connection with the great deposit of fish scales, spines, &c., in the Moyola, parish of Ballynascreen. The old red conglomerate shown on the right of the section is not actually seen in the line, but as it appears immediately adjoining it to the south, it is continued into the section and supposed to be connected with the anticlinal line occurring there (page 573).

FIG. 7.—Shows the position of the limestone of Cullion. The old red conglomerates both rise above, and appear below this deposit with a reversed dip, and the probable arrangement is as shown in the section. The elevation of the limestone at Desertmartin is marked on the section (see also Plate D. lower view). Resting on the upturned edges of the old red conglomerate is seen a small patch of the lower carboniferous shales, which in the line of section appear horizontal. Slieve Gallion Carn is represented behind the section, in order to show the relation of its basaltic cap, chalk, and new red strata to the older deposits, though by a reference to the Map, it will be seen that it is actually at the other side of the section, and therefore in reality would not be visible (pages 579, 580, 593).

Fig. 8.—This small section will give some idea of the alternating deposits of coarse conglomerates and shales on the White Water. It would be impossible to show the actual succession in detail, excepting on a very large scale (pages 565, 576).

Fig. 9.—Section at Benburb, showing the succession of beds exposed in the Blackwater River, and the cuttings for the Ulster Canal. The lower portion consists chiefly of limestone, which is succeeded in the upper beds by sandstone and shale, belonging to the third division of this Report. The strata of the new red overlie the carboniferous at either side of the section. The line of this section has not been marked on the Map, to avoid confusion; it corresponds, however, to the line of dip, and can therefore be readily compared with the Map.

Plate F.

This plate requires a little more explanation. The section is continued in a right line from Lough Foyle to Lough Neagh, passing, of course, through all the formations in the country, and in many cases crossing them obliquely, as regards the dip. The difficulty arising from this circumstance is obviated by the use of the small diagrams, as before explained, the section being constructed in the same manner as the others. The strong line, along which the elevations are marked, represents the surface on the line of section; while behind the section, the outline of the hills is given, the proper colour being used to represent the geological structure. This section must be read in connection with the Map; and it should be stated, that the position of the hills is projected at right angles to the line of section, their actual or geometrical height being shown without any allowance for perspective. If studied in this way the advantage of such a mode of representation will be obvious. In figs. 1 and 2, the same line of headlands is seen, as were shown in another point of view on Plate B. This section also forcibly illustrates the dependence of the physical features on the geological structure, the elevated ridges of the igneous and primary rocks contrasting well with the low and undulating valleys of the sandstones and softer strata.

Plate G.

Fig. 1.—Is the remarkable outlier of trap, chalk, and new red, resting in a hollow of the carboniferous strata at Stewartstown, County Tyrone. The mountain limestone is seen at either side. In the upper beds it is very cherty, and abounds with Productæ, &c. The lower beds are divided by layers of shale, and intercalated beds of sandstone and conglomerate; and still lower in the series, the strata are one mass of corals in their natural mode of growth. The portion above the uppermost bed of the mountain limestone, shown on the section as covered by detritus, probably belongs to the upper member, and forms a continuation of the Annaghone deposits (Chap. XII.)

Fig. 2.—Section of the silurian strata at Pomeroy. The relations of the granite and hornblendic rocks at the base of this section are not distinct, and nothing more is therefore attempted than to show the extent of each; the succession of the strata above them appears in the line of section regular, though concealed in parts by detritus, and disturbed to the west. The old red conglomerates appear conformable to the upper beds of the silurian in this section (Chap. X.)

Fig. 3, Is a section of the Annagher Colliery, contributed by Mr. Griffith. It shows the downthrow and faulty ground, &c. (Chap. XII, and Plate H., fig. 2). Quoted by mistake as fig. 5, page 609.

Fig. 3*. Is a section of the Lewin Pits, Drumglass, showing the great upthrow or roll in the coal, and a general section of the strata. See Chap. XII, and Plate H. (referred to by mistake as fig. 5*, page 620.)

Fig. 4.—Section in the neighbourhood of Clogher. The bold escarpment and anticlinal line of the old red conglomerates is seen on the left of the section, succeeded by limestone and shales, here referred to the second division of the carboniferous series, and resting on the lower or Modiola shales, brought to view by elevation, and again dipping under the limestone to the south. Resting on this is a series of sandstones, fossiliferous grits, and shales, the third member of this Report, whilst still further to the south, forming

the axis of the hill, are shale and limestone beds, probably belonging to the second division, and again capped by sandstones and shales dipping to the south. See Chap. XII.

Fig. 5.—In the neighbourhood of Fivemiletown, shows a slightly different arrangement of the same series, further to the west. The Modiola shales here occur resting on the old red, at the base of the series, and are succeeded unconformably by limestones and shales of the second member, which are again succeeded by fossiliferous grits and shales, as in fig. 4. The sectional position of these is here doubtful, but their probable arrangement is shown on the section. Near the southern extremity of the section the shaly and calcareous beds of the second member are again seen.

Figs. 6, and 7.—Are a general section from Donegal to the south of Fermanagh. Resting on the mica schist of Donegal is a thin deposit of the old red, succeeded by grits and shales of the carboniferous series; on these immediately rest the first limestone which is succeeded by shale, shaly sandstone, and sandstone, rising in Greaghmore to 635 feet. The section next passes through shales, abounding with Modiolæ, and fossiliferous sandstones. The difficulty attending the determination of the sectional position of these strata has been spoken of (Chap. XII.)

The section passes across the great extent of the old red sandstone, and cuts the small silurian deposit at Lisbellaw, showing the manner in which it has been thrown up in an anticlinal axis, and is succeeded by a thin stripe of the old red, and the limestones and shales of the carboniferous system. See Chaps. IX and X.

Plate H.

Is a general plan of the more important workings in the Drumglass coal field. The very disturbed and broken nature of the field will be evident at a glance, from the irregularity of the plan. The last headway worked was that to the north-east of the plan. The coal was here found more regular than usual, but owing to the quantity of water, the workings are for the present abandoned. Unfortunately no section of this field has been constructed during the workings. The Lewin Pits, now working, are shown in the north-west corner of the plan. For section see plate G., fig. 3*. (page 620). The small plan introduced on the right of plate H .shows the workings from pit No. 2. (see section, Plate G., fig. 3.) in the five foot seam, at Annagher colliery, near Coal Island.

Plate I.

A series of views of detritus showing the varied manner in which gravel deposits have been formed. See Chap. XIII.

FOSSILS.

Plate I.

Fig.	Page.	
1 a.	256	Remopleurides *Colbii*. 1 b segments magnified.
2 a.	256	„ *lateri-spinifer*, 2 b seg. mag.: 2 c caudal seg. do.
3 a.	256	„ *dorso-spinifer*, 3 b central seg. mag.: 3 c caudal do., 3 d dorsal spine, 3 e wing spine.
4	257	„ *dorso-spinifer*, cephalothorax.
5	257	„ *longi-capitatus*,
6	257	„ *longi-costatus*,
7 a.	257	Ceraurus *globiceps*, 7 b shows position of eyes: 7 c seg. mag.
8	258	Paradoxides *Bucephali*.
9, 10	258 260	Ampyx *Sarsii*, 9 b seg. mag., 10 a, 10 b various heads.

Plate I. b.

1, 2.	261	Ampyx *Austinii*.
3, 4, 5.	262	Trinucleus *Caractaci*, various individuals.
6	263	„ intermediate between T. *Caractaci* and T. *elongatus*.
7	263	„ *elongatus*.

PLATE I. B. (continued.)

Fig.	Page.	
8	263	Trinucleus *seticornis.*
9	264	„ *radiatus.*
10	264	„ intermediate between T. *elongatus*, and T. *fimbriatus.*
11, 12	264	„ *fimbriatus.*
13, 14	264	„ abnormal specimens : 13 b, 14 b, sections of do.
15	264	„ a large pygidium.
16, 17	265	„ a portion of the crust removed and its impression.

PLATE II.

Fig.	Page.	
1 a	281	Phacops *truncatocaudatus*, 1 b pygidium of the same spec. turned over : 1 c pleuripedes, 1 d portion of eye mag.
2	281	„ „ another spec. showing the prolongation of the wing in spines.
3	281	„ „ impression of expanded spec.
4, 5, 6	281	„ „ 4. pyg., more elongated : 5, 6 central pyg. lobes of various forms.
7 a	282	„ *Dalmanni*, upper and under view : 7 b seg., 7 c eye, see also Plate III., 7 d.
8 a	282	„ *Brongniartii*, 8 b cephalothorax mag., 8 c eye, see also Pl. III.
9 a	283	„ *Murchisonii*, 9 b cephthor., see also Pl. III., 9 c, 9 d.
10 a	284	„ *tuberculatus*, side view, 10 b cephthor., 10 c pyg. Eifel spec.

PLATE III.

Fig.	Page.	
1 a	285	Calymene *Blumenbachii*, 1 b. pyg.
2	286	„ *pulchella.*
3	286	„ *brevi-capitatus.*
4 a	289	Amphion *gelasinosus*, 4 b another spec.
5 a	291	„ *pseudo-articulatus*, shows form of cephthor., 5 b the seg. and general form, 5 c the pyg.
6 a	291	„ *multi-segmentatus*, 6 b caudal extremity of pyg.
7 d	282	Phacops *Dalmanni*, mag. outline of cephthor.
8 d	282	„ *Brongniartii*, pyg. mag.
9 c	283	„ *Murchisonii*, pyg., 9 d cephthor. mag.
10 a	283	„ *Jamesii*, cephthor., 10 b pyg.
11	262	Ampyx *baccatus.*

PLATE IV.

Fig.	Page.	
1	274	Nuttainia *Hibernica*, 1 b antenniform process, 1 c, 1 d pyg.

PLATE V.

Fig.	Page.	
1, 2	274	Nuttainia *Hibernica*, cephthor. showing the lateral division, and neck seg.
3 a	„	„ „ another spec. showing in 3 b the under side.
4 a	267	Harpes *Doranni*, 4. b impression of do., 4 c the animal restored.
5 a	268	„ *Flanaganni*, 5 b restored.
6 7	„	„ „ another spec., seen both from above and from below.
8 a	270	Brontes *Hibernicus*, pyg., 8 b. another spec., axal lobe more perfect.
9 a	272	Arges *plano-spinosus*, caudal extremity, 9 b. another spec.
10	302	Ogygia ? *rugosa*, pyg.

PLATE VI.

Fig.	Page.	
1	297	Isotelus *Powisii.*
2	298	„ „ Pyg. intermediate between I. *gigas*, and I. *Powisii.*

PLATE VII.

Fig.	Page.	
1	295	Isotelus *gigas.*
2, 3	295	„ *planus*, 3 the buccal apparatus.
4.	297	„ „ showing the eyes.
5, 6	292	Asaphus *latifrons*, 6 b seg. mag.
7	293	„ *marginatus.*

PLATE VIII.

Fig.	Page.	
1	295	Isotelus *planus (gigas,)* showing the pronged appendage.
2	„	„ „ cheeks, with portion of crust removed.
3	„	„ „ cephthor. looked into from below.
4 a, 4 b	296	„ „ buccal apparatus.
5	297	„ *ovatus.*
6	„	„ *planus*, pleuripedes.
7	295	„ „ probable articulating process of cheeks.

Plate IX.

Fig.	Page.	
1 a, 1 b	298	Isotelus *rectifrons*, cephthor.
2, 3.	„	„ *ar*[illegible], pygidia.
4 a, 4 b	299	„ *l*[illegible].
5	„	„ *intermedius*, 5 b. pyg.

Plate X.

1. 2.	299	Isotelus *sclerops*.
3,4,5,6	300	Illænus *centrotus*.
7, 8, 9	301	„ *crassicauda*.

Plate XI.

1	307	Phillipsia *Kellii*, b, c, d, various parts mag.
2	„	„ *ornata*.
3	308	„ *Jonesii*, 3 b, c, d, parts mag.
4	307	„ *ornata*, a monstrosity.
5	308	„ *Jonesii*, var. seminiferus.
6	309	„ *Maccoyi*, 6 b mag.
7	310	Griffithides *longiceps*, 7 a cephthor, 7 b pyg.
8	311	„ *platyceps*.
9	„	„ *globiceps*.
10	„	„ ——— corresponds in character to 7. b.
11	„	„ ——— slightly varied from do.
12	312	„ ——— variety.
13	„	„ ——— do.

Plate XII.

1, 2	314	Dithyrocaris *Colei*, 3 a, 4, 5, caudal portion, 3 b attached serpulæ, mag., 6. buccal apparatus.

Plate XIII.

1, 2, 3	463	Holoptychius *Portlockii*, 1 b reticulated portion mag.
4, 5	„	„ „ other forms of the same.
6	464	„ „ smooth glossy scale.
7	„	„ „ scale probably belonging to head.
8, 9	463	„ „ teeth.
10	464	„ „ tooth with fine furrowed base.
11, 12	„	„ „ other forms.
13 a	„	„ „ inner view of probable part of jaw, 13 b outer view of do.
14, 15	463	Gyracanthus *tuberculatus*, two specimens.

Plate XIV.

1 a	463	Palæoniscus *Egertoni*, scale : 1 b lower surface.
2 a	473	Holoptychius ——— scale : 1 b do. mag.
3 a	463	Palæoniscus ——— scale imbricating dorsal fin, 3 b do. mag.
4 a	„	„ ——— another form, 4 b do. mag.
5	„	„ ——— another form granulated.
6	464	Tristychius *minor*, dorsal spine.
7	467	Ctenoptychius *macrodus*, tooth.
8	466	Chomatodus *linearis*, tooth.
9 a	468	Petalodus *rectus*, tooth, 9 b opposite side.
10	„	„ *Hastingsii*, tooth with portion of edge mag.
11 a	469	Gyrolepis *tenui-striatus*, scale, 11 b, 11 c mag. views of both surfaces.
12a, 13a	„	„ *Albertii*, scales 12 b 13 b the same mag.
14 a	„	„ „ the laminated structure, 14 b mag.
15, 16	„	„ „ also the laminated structure, species doubtful.
17 a	„	Acrodus ——— tooth, supposed new species, 17 b. mag.
18 a	„	„ *minimus*, tooth, 18 b. mag.
19 a	470	Saurichthys *apicalis*, tooth, 19 b. mag.
20	„	Coprolite „ studded with fragments of scales and teeth.

Plate XIV. a.

1	465	Psammodus *porosus*, tooth with portion of surface mag.
2	„	„ ——— two teeth intermediate between *porosus* and *rugosus* with part of surface mag.
3	466	„ *cornutus*, tooth.

PLATE XIV. A. (continued.)

Fig.	Page.	
4	466	Cochliodus *magnus*, tooth with portion of surface mag.
5 10	,,	,, *oblongus*, teeth.
6	468	Pæcilodus *Jonesii*, tooth.
7	,,	,, *transversus*, do.
8	467	Orodus *ramosus*, tooth, upper and side view.
9	,,	Chomatodus *cinctus*, tooth, opposite views.
11	468	Pæcilodus ? Cephalaspis ? tooth ? abdomen ? natural size and mag.
12	464	Megalichthys *Hibbertii*, scale.
13, 15	462	Palæoniscus *Robisoni*, scales.
14	,,	Palæoniscus ? Amblypterus ? scale.
16	466	——————— probably portion of head of a fish.
17	317	Crustacean ——————— supposed claw, natural size and mag.

PLATE XV.

1	345	Trochocrinites *lævis*.
2	,,	Crinoidal *columns*, 2 b. section of do.
3	346	——————— auxiliary side arm of a crinoid.
4, 5, 6	347	Actinocrinites *amphora*, 4 a base, 4 b one of the plates mag., 5 a summit 5 b side view, 6 a monstrosity.
7	348	,, *icosidactylus*, 7 b section of do.

PLATE XVI.

1	348	Actinocrinites *amphora*, probably columns of: 1 b section.
2	,,	,, *triacontadactylus*, 2 a column, 2 b section.
3	,,	Platycrinites *rugosus*.
4	,,	,, *granulatus*.
5	349	Gilbertsocrinus *simplex*, 5 a base, 5 b side view.
6		Platycrinites ——— joint of stem.
7, 8, 9	,,	Actinocrinites *triacontadactylus*, columns, 7 b, 8 b, 9 sections of do.
10	352	Cidaris *Benburbensis*, 10 a, 10 b plates, 10 c spine, 10 d do. mag.
11	,,	,, ——— plate of do., different in form.
12	350	Poteriocrinites *conicus*.
13	,,	Platycrinites *rugosus*.

PLATE XVII.

1 a	355	Holaster *Sandoz* ? 1 b side view.
2 a	,,	,, *æqualis*, 2 b base, 2 c side view.
3 a	354	Ananchytes *ovatus*, 3 b base, see pl. XVIII.
4 a	358	Diadema *corollaris*, 4 b side view, 4 c plates mag.

PLATE XVIII.

1 a	354	Ananchytes *conoideus*, 1 b base.
2 a	,,	,, *ovatus*, 2 b base.
3 a	356	Galerites *vulgaris*, 3 b base.
4 a	358	Cidaris *acrocidaris*, 4 b base, 4 c side view.
5 b	,,	,, *vesiculosus*, 5 a side view.

PLATE XIX.

1, 2	318	Graptolithus *Sedgewickii*.
3 a	319	,, ,, the same spec., 3 b the portion mag.
4 a	,,	,, *distans*, 4 b portion mag.
5	,,	,, *convolutus*.
6 a	,,	,, *Sedgewickii*, more delicate spec., 6 b mag.
7 a	,,	,, *tenuis*, 7 b mag.
8 b	320	,, *sagittarius*, 8 a various portions mag.
9 a	,,	,, *foliaceus* ? 9 b mag., 9 c more flattened.
10	,,	,, *pristis*.
11 a	,,	,, ,, ? more robust spec., 11 b mag.
12 a	231	Tentaculites ? ——— 12 b mag.

PLATE XX.

1	320	Graptolithus *sagittarius*.
2	321	,, ——— curved lines, like septa.
3	,,	Prionotus Scalaris ? *Hisinger*.
4	320	Graptolithus *Sedgewickii*.
5	321	,, *Folium*.

PLATE XX. (continued.)

Fig.	Page.	
6	323	Gorgonia *regularis.*
7	330	Turbinolia *fibrosa*, 7 a in relief, 7 b impression.
8	322	Gorgonia *undulata.*
9	325	Catenipora *labyrinthica.*
10	326	Stromatopora *polymorpha.*

PLATE XXI.

Fig.	Page.	
1 a	323	Gorgonia *capillaris*, 1 b mag.
2 a	326	Favosites *polymorpha*, 2 b casts of the tubular openings.
3 a	339	Ptilodictya *dichotoma*, 3 b mag.
4 a	326	Intricaria *obscura*, 4 b mag.
5 a	360	Entobia *antiqua*, 5 b mag.
6 a	339	Ptilodictya *dichotoma*, 6 b mag.
7	"	Alga ? ——— doubtful fossil in the silurian schists.

PLATE XXII.

Fig.	Page.	
1 a	324	Fenestella *flabellata* 1 b, 1 c mag. portions. see Pl. XXII. A.
2	"	" *tenuifila ?*
3 a	323	" *polyporata* 3 b, 3 d mag., see Pl. XXII. A.
4 a	326	Favosites *tumida* 4 b pores. mag.
5	335	Lithodendron *coarctatum.*
6 a	337	Syringopora *geniculata* 6 b, secs. through tubes.
7	"	" *reticulata.*

PLATE XXII. A.

Fig.	Page.	
1 a	323	Fenestella *polyporata*, 1 b mag., 1 c, 1 d poriferous side, nat. and mag.
2 a	325	" *irregularis ?* 2 b, mag.
3 a	324	" *intertexta*, 3 b, 3 d portions mag.
4 a	"	" *flabellata*, 4 b mag., see Pl. XXII.
5 a	325	Retepora *prisca*, 5 b mag.
6 a	327	Favosites *serialis*, 6 b mag.
7 a	339	Vincularia *multangularis*, 7 b mag.
8 a	340	Glauconome ? 8 b mag.

PLATE XXIII.

Fig.	Page.	
1	332	Astræa *hexagona.*
2	"	" " smaller var.
3 a	333	" *irregularis*, 3 b base ⅓ of nat. mag., 3 c sec., 3 d cell mag.
4 a	"	" " smaller var., 4 b cell mag.

PLATE XXIV.

Fig.	Page.	
1	292	Amphion *pseudo-articulatus ?* very large pyg.
2	302	Illænus *quadrato-caudatus*, pyg. 9, and part of thorax.
3	293	Asaphus *dilatatus*, pyg.
4	274	Nuttainia *obscura*, cephthor.
5	381	Gomphoceras *subfusiforme ?*
6	302	Illænus, Glabella.
7	361	Lumbricaria *antiqua.*
8	362	Aphrodita ?
9	329	Turbinolopsis *elongata ?*
10	470	Trilobite ? ——— ? internal cast of cephthor.
11	316	Limulus *trilobitoides.*
12 a	312	Griffithides *longispinus*, 12 b side view, 12 c pyg., 12 d pyg. partly decorticated, 12 e seg.
13 b	316	Cypris *subrectus*, 13 a, this and the next spec. mixed together.
13 c	"	" *Scoto-burdigalensis.*

PLATE XXV.

Fig.	Page.	
1 a	365	Orthoceras *calamiteum*, 1 b mag.
2	366	" *gracile.*
3 a	367	" *tubicinella*, (var. *subnodosum*), 3 b section.
4	"	" " (var.) elliptic.
5, 6	"	" *perannulatum*, 5, young, 6 is drawn ½ nat. mag.
7, 8	368	" *sub-annulare.*

PLATE XXV. A.

Fig.	Page.	
1	455	Terebratula *lacunosa*, *(Murc.)* dorsal and ventral valves.
2, 3	451	Orthis *callactis*, 2 an elongated var.
4	424	Posidonomya *venusta.*
5, 6	426	Mytilus *cinctus.*
7	430	Mytilus ? *semirugatus.*
8	455	Uncites *gryphus*, var.
9 a	362	Serpula *socialis*, 9 b. portion mag.
10	431	Pterinea *Thompsoni.*
11	458	Orthis *orbicularis.*
12 a	„	„ *umbraculum*, var. 12 b, portion mag.
13	459	„ *pulchra*, the larger figure is magnified.
14, 15	127	Pecten *Valoniensis.*

PLATE XXVI.

Fig.	Page.	
1	378	Koleoceras, sheath ½ nat. mag.
2	379	„ *pseudo-regulare*, ½ nat. mag.
3	380	„ *pseudo-speciosum*, ½ nat. mag.
4, 5	370	Orthoceras *Pomeroense*, ½ nat. mag., 5 section.
6 a	371	„ *subcostatum*, 6 b mag.
7	379	Koleoceras *pseudo-regulare ?* see also p. 377.

PLATE XXVII.

Fig.	Page.	
1	378	Koleoceras *pseudo-regulare.*
2 a	372	Orthoceras *elongato-cinctum*, 2 b, another spec. showing the septa.
3 a	370	„ *lineatum*, 3 b obscure marking of septa.
4, 5	377	„ *regulare ?* 5 in part transversely lineolated.
6	384	„ ——— not determinable, figured for comparison.
7	367	„ *tubicinella*, with a sheath, Koleoceras ?
8	386	„ *gregarium ?*
9	387	„ *affine.*

PLATE XXVIII.

Fig.	Page.	
1	370	Orthoceras *lineatum.*
2	373	„ *subundulatum.*
3	372	„ *subflexuosum.*
4	368	„ *Brongniartii*, ½ nat. mag.
5, 6	373	„ *tumidum*, ½ nat. mag.
7	374	„ *incertum.*
8 a	373	„ *brevi-conicum*, 8. b. opposite side crushed.
9	374	„ *subarcuatum*, with section.

PLATE XXVIII. A.

Fig.	Page.	
1 a	381	Gomphoceras *subpyriforme*, 1 b, opposite side crushed.
2 a	380	Koleoceras *Ballii*, 2 b, sheath removed.
3 a	375	Orthoceras *triangulare*, 3 b shell removed, 3 c flat side.
4 a	382	Phragmoceras *inæquiseptum*, 4 b inner side.
5 a	„	„ *arcuatum*, 5 b inner side.

PLATE XXVIII. B.

Fig.	Page.	
1	374	Orthoceras *complanato-septum.*
2	382	Phragmoceras *compressum ?* ½ nat. mag.
3	383	„ *Brateri ?*
4 a	„	„ ? ——— 4 b side view.
5 a	384	Cyrtoceras *obliquatum ?* 5 b front view, 5 c mag.
6	383	„ ? ——— two views.
7	„	Lituites *cornu-arietis*, side and edge.

PLATE XXIX.

Fig.	Page.	
1	398	Bellerophon *dilatatus*, var.
2 a	397	„ *bilobatus*, var. compressus, 2 b back and aperture.
3, 4 a	„	„ *elongatus*, 4 b whorl exposed.
5	398	„ *gibbus.*
6 a	399	„ *decussatus*, 6 b portion mag.
7 a	400	„ *striatus*, (Flem.) 7 b portion mag.
8 a	„	„ *clathratus* (D'Or.) 8 b port. mag.

PLATE XXIX. (continued.)

Fig.	Page.	
9	400	Bellerophon *Urii.*
10	401	" " var.
11 a	402	" *interlineatus*, 11 b port. mag.
12 a	401	" *D'Orbignii*, 12 b side view.
13 a	399	" *Larcomii*, ½ nat. mag., 13 b side view, 13 c spire exposed.

PLATE XXIX A.

1	471.	Conularia? *an elongated* division of side?
2	393	" *elongata.*
3 a	"	" *quadrisulcata*, (sil. var.) 3 b another spec. and port. mag.
4, 5	"	" " (carb. var.) with port. mag.
6, 7 a	470	Cephalopoda, *internal bone?* 7 b port. mag.
8	406	Nautilus *goniolobus?* with port. mag.
9	407	Goniatites *granosus*, with port. mag.
10	404	Nautilus *quadratus?*
11	403	" *perplanatus.*
12	134	Ammonites *Macdonnellii*, 12 a sinuosities of septa.
13	138	" *Sampsoni*, 13 a septa., 13 b section.

PLATE XXX.

1	411	Euomphalus *parvus*
2	410	" *sculptus.*
3	409	" *subsulcatus.*
4 a	412	Schizostoma *latifasciatus*, 4 b base.
5	410	Euomphalus *granulatus.*
6	"	" *lineatus.*
7 a	413	Pleurotomaria *turrita*, 7 b base.
8	414	" *sub-rotundata.*
9	"	" *trochiformis.*
10 a	411	Ecculiomphalus *Bucklandi*, 10 b reverse.
11, 12	412	" *minor.*

PLATE XXXI.

1	414	Trochus *ellipticus.*
2	416	Polyphemopsis *elongatus*, two views.
3	415	Loxonema *obscura.*
4	418	" *tenui-striata.*
5	"	Murchisonia *angulata*, see Pl. XXXVIII.
6	420	Natica *plicistria*, var. *a*, two views.
7	"	" " var. *β.*
8	"	Nerita *spirata.*
9	419	Macrocheilus *imbricatus*, two views.
10	"	" *percinctus.*
11	420	Turritella *sulcifera*, greatly mag.

PLATE XXXII.

1, 3	443	Lingula *lata.*
2	"	" *brevis.*
4	"	" *attenuata.*
5 a	"	" *squamiformis*, 5 b, 5 c other spec.
6, 8, 9	444	" *parallela.*
7	"	" *mytiloides.*
10	445	Orbicula *subrotunda.*
11, 12	"	" *lævigata.*
13	"	" *elongata.*
14	446	" *nitida?*
15, 16	"	" *cincta.*
17, 18	450	Orthis *corrugata*, with portion mag.
19	"	" *cancellata*, with portion mag.
20, 21	"	" *sericea*, varieties.
22	"	" " do.
23, 24	"	" " ordinary form, with portion mag.
25	452	" *grandis.*

PLATE XXXIII.

Fig.	Page.	
1, 2, 3	423	Inoceramus *vetustus*, (var. *priscus*).
4	422	„ *trigonus*, 4 a side view.
5	„	„ *contortus*.
6	425	Modiola *expansa*.
7	„	„ *Brycei*.
8	„	„ *securiformis*.
9	471	Bellerophon *alatus*.
10	424	Modiola *Nerei*.
11	423	Inoceramus *transversus*.

PLATE XXXIV.

1	427	Arca *subtruncata*.
2	„	„ *regularis*.
3	„	„ *Eastnori ?*
4	428	„ *transversa*.
5	„	„ *dissimilis*.
6	429	„ *obliqua*.
7	„	Pectunculus *semitruncatus*.
8	„	„ *Apjohnni*.
9	428	Arca *cylindrica*.
10	430	Nucula *acuta*, var. *imbricata*.
11	„	Pectunculus ? *ambiguus*.
12	472	Posidonomya *complanata*, nat. size and mag.
13	432	Modiola *Macadamii*, var. angusta.
14	„	„ „ var. elongata.
15	„	„ „ var. lata.
16	433	„ *subparallela*.
17	441	Cypricardia ? *tricostata*.
18	433	Sanguinolaria *plicata*.
19	119	Panopæa ? *elongata*.
20	434	Sanguinolaria *undata*.
21	„	„ *transversa*.

PLATE XXXV.

1 a	403	Nautilus *planidorsatus*, 1 b outline section.
2 a	390 472	Orthoceras *latissimum*, longitudinal section, 2 b side view.
3	388 472	„ *maximum*, longitudinal section.
4 a	471	Bellerophon *Oldhami*, 4 b back, 4 c aperture, 4 d port. mag.
5 a	472	„ *recti-costatus*, side view, 5 b aperture and part of shell.
6 a	471	„ *spiralis*, side view, 6 b mag., 6 c aperture, 6 d mag.

PLATE XXXVI.

1	434	Sanguinolaria *maxima*, with outline sect.
2	„	„ *oblonga*, with outline sect.
3	435	„ *? attenuata*.
4	441	Solen *pelagicus*.
5	„	Lutraria *primæva*, lateral and dorsal views.
6	439	Amphidesma *axiniformis*.
7	„	„ *deltoidea*.
8	438	„ *carbonaria ?*
9	436	Pecten *semicostatus*.
10	„	„ *Ottonis ?* var.
11	430	Nucula ? *radiata*.
12	439	Nucula *lævi-rostrum*.
13	440	Pullastra *bistriata*.

PLATE XXXVII.

1	452	Orthis *expansa*, var. concentrica.
2 a	453	„ *rugifera*, 2 b young.
3	454	„ *intercostata*.
4	„	Spirifera *cyrtæna ?*
5	456	Orthis *umbraculum*, three views.
6	459	Spirifera *laxa*.

PLATE XXXVIII.

Fig.	Page.	
1	460	Atrypa *gibbera*, a front, b side, c back.
2	567	,, *sublobata*, a—k various modifications some perhaps specifically distinct.
3	,,	Spirifera *partita*, two views.
4	,,	Terebratula *ferita* ?
5	,,	Inoceramus *Pernoides.*
6	568	Unio ? doubtful casts.
7 a	594	Sphenopteris *linearis*, 7 b port. mag.
8 a	746	Spirifera *octoplicata*, var. ventral valve, 8 b dorsal.
9	745	Posidonomya *transversa.*
10 a	569	Murchisonia *elongata*, 10 b port. mag.
11	746	Turbo *appropinquans.*
12	571	Lucina *Du Noyeri.*

ERRATA.

Page 37, *line* 35, *for* Dolomien *read* Dolomieu
53.......12 .... Leay *read* Leap
84....... 9 .... Moilaghash *read* Mullaghash
98.......34 .... island *read* promontory
119.......33 .... Pallustra *read* Pullastra
123.......23 .... *Duncrum* read *Duncrun*
123.......36 .... faniatus *read* fasciatus
130 last line .... sugged *read* rugged
363.......17 .... *Killushiel* read *Killeeshil*
364....... 3 .... Tyrone *read* Antrim
404.......14 .... recutering *read* re-entering
419....... 1 .... triconnate *read* tricarinate
419....... 5 .... Rostellana *read* Rostellaria
461....... 4 .... Roan *read* Rhone

368.......29 Pl. XXVII. *read* XXVIII.
370....... 1 .... XXIV. *read* XXVI.
397.......34 .... XXIX. B. *read* XXIX.
411....... 5 .... XXXI. *read* XXX.

REPORT

ON THE

GEOLOGY OF THE COUNTIES LONDONDERRY, TYRONE, AND FERMANAGH.

CHAPTER I.

INTRODUCTORY REMARKS.

COLOURING—GEOLOGICAL DIVISIONS—SIGNS.

The objects are few, if any, in nature which do not admit of contemplation, and require to be studied under two distinct points of view. They may be considered simply in their practical bearings on the existence and occupations of man; or they may be investigated as subjects for scientific research, in the hope of discovering their composition, and the hidden cause of their external qualities. It is thus that the air we breathe, the water we drink, the food we eat, and the earth we tread on, are regarded either practically as simple bodies ministering to our physical wants, or scientifically as compounds of elements, bound together by definite laws, and influenced by circumstances, the study of which is replete with interest and instruction. Of the two systems the practical, in its simplest form requiring little more than an exercise of the senses, naturally precedes more laboured mental investigations; in its matured stage it assumes a character of science whilst seeking to apply theory, or the results of scientific investigations to practical purposes. Resting on these principles it is reasonable to expect that the physical features of the earth's surface should be amongst the first objects of man's attention, as they exercise an influence on his ordinary pursuits, by either facilitating or impeding them, too powerful to be overlooked or neglected. The lake or the river, the plain, the rocks, the hill, or the mountain, are not regarded merely as objects of refreshing or picturesque beauty; they possess other claims on attention, some appearing formed to promote human intercourse, others to obstruct it; yet all contributing in different ways, direct or indirect, to advance it. The external difference between a level plain and an elevated mountain range, is too great to pass unnoticed by the least observant; the ease with which the one is traversed is so strongly contrasted with the difficulty of ascending and passing over the other, as to bring the difference practically before the senses, and yet the advantages which co-exist with or flow from this first and most simple form of difference in the physical features of the earth's surface, are often scarcely felt and still less appreciated. The mountain range has other important functions to perform, inasmuch as it influences climate, and induces additional variety in organic existences; but viewed in its more ordinary and practical aspect it also deserves attentive consideration. In times, not very remote, the common road of human traffic was carried over the mountain ridge, encountering and mastering those steep ascents which now would turn away the roadmaker in despair; some of the qualities of the mountain range were either unnoticed or disregarded, and the apparent object was to conquer rather than to follow nature; such roads (the remains of which still astonish the traveller in the mountain districts of Ireland) carried directly over the summits of mountains, were, however, in part the result of necessity, as the difficulties of forming a winding and level road in a wooded country would have been formidable. The mountain chain, if it occasionally obstructs, is generally a powerful instrument in advancing the progress of man; it collects together, and gives a definite direction to those streams of water, which ultimately as rivers become means of commercial intercourse and in the wide expanses of their estuaries and of the bays which receive them at their efflux into the sea, afford ports or havens of retreat to ships, the ultimate carriers of the produce of one country to another: hence the mountain ridge marks out the various channels of internal and external intercourse, and stands as a natural boundary to limit the field of productive supply to each. How important then, economically, is a comparative examination of the elevated and level districts of a country, to the proper arrangement of the various lines of communication, whether by roads or canals, and to the selection of the ports to which individually they should be directed. This, then, is the consideration which first arrests the attention of the practical geologist, in his examination of mountain and plain.

The next circumstance which attracts the attention of the observer, is the variety of composition which characterises the several portions of the earth's surface. In one place he finds a sandstone, in another a limestone, in a third a slate; and in each of these substances he further notices many and striking differences. The composition, therefore, is as varied as the physical features of the earth's surface; yet great as are its differences, in a practical sense they are easily recognised and appreciated: granite, porphyry, slate, freestone, marble, limestone, chalk, flint, clay, sand, being terms so familiar to, and understood by every one, as to admit of little difficulty or doubt in their practical application. If, however, these substances be viewed scientifically, the case is altered; it is then no longer sufficient to know that one sandstone is a good, and another a bad building stone, that one limestone is pure and another impure, that one clay is fitted for coarse and another for fine pottery: new and more interesting questions now arise, and it is asked why all these local differences exist, if any necessary connexion can be traced between them, and if they can be brought into relation with the observable laws of nature? In short those objects which were at first viewed individually as fitted for particular practical purposes, are now contemplated as parts of a greater whole, and become so many subjects of philosophic investigation and deduction.

Following this higher principle of inquiry, it is at once seen that substances so widely different as conglomerates, sandstones, shales, limestones, must have originated in causes, as different in their mode of operation as those which now produce in one place gravel or shingle, in another sand, in a third mud, in another marle, and in others solid limestone; and when relics of organic bodies are discovered either mingled with the sand or gravel on the surface, or imbedded in the solid strata it is no longer matter of surprise that the more ancient writers should have ascribed the production of such strata to the action of ancient seas, whilst it excites astonishment that so many of the modern should have sought in other than existing causes types of the forces which produced them. Nor is it without instruction that we consider the opinions of some of those ancient authors:—"that the sea frequently flitted and changed its place: that several parts of the globe which are now dry land, and habitable, lay heretofore at the bottom of the sea, and were covered by it: that particularly the very countries which present us with these spoils of it, were anciently in its possession; being then a habitation of sharks and other fishes, of oysters, cockles, and the like;" or that such "tracts of land which lay till then at the bottom of the sea, being raised to a higher pitch, so as to surmount the level of its surface, became by that means, islands and habitable; the said tracts being thus elevated by earthquakes, or the like subterraneous explosions; in such manner as Rhodes, Thera, Therasia, and other islands, were supposed to have been raised." Opinions which embodying sound and enlightened principles now rendered familiar to every one by the writings of modern geologists, more especially by those of Mr. Lyell, were then quoted by Woodward, not with the intention of illustrating and supporting them, but in order to explain how those ancient writers could have fallen into what he considered such grave errors. As, however, every new day is confirming by fresh evidence, the validity of these principles, it is unnecessary to dwell further upon them.

The progress of investigation soon led to the perception of differences in what might otherwise have been considered alike: one sandstone, one shale, or one limestone, was soon seen to differ from others, if not in composition or general appearance, at least in position, and the idea of succession having been seized, it became necessary to adopt terms expressive of that new feature of relation, whence arose the Wernerian designations—first and second sandstones; first, second, and third flœtz limestones, &c. terms which, independent of the appellation 'flœtz,' have at least this advantage over old and new red sandstone, yellow sandstone, variegated sandstone, white limestone, &c., that they express sequence and position, without appealing as evidence to the fleeting and uncertain characters which are afforded by colour. Still, however, admitting that one sandstone, one shale, or one limestone, was formed before or after others, the question must be asked, how is the first to be distinguished from the last? and in this rests all the difficulty of practical geology.

Where an unbroken succession of strata can be observed, the order of sequence, and formation, except in some peculiar cases of disturbance, is manifest, the lowest having been necessarily first formed, the highest the last. But such favourable circumstances of observation are rare in nature; and it more frequently happens that the relative position of strata must be determined without a power of immediately tracing them to their connexion with those either geologically anterior or posterior to them. In such cases the mode and order of arrangement are usually first tested by comparing the direction of the dips of the strata which it is wished to connect together; but this method, though often effectual, is not without difficulties, and is subject to numerous exceptions, the neglect of which would lead the enquirer into error. This will be understood on examining the present sea-coast, at points where ledges of rocks, as for example the Skerries on the N.E. of Derry, are in advance of it, as it may readily be there seen, that deposits of sand and gravel now forming on the coast and dipping outwards to the sea, will at a future period when consolidated into strata, appear to dip under the advanced rocks; an effect which will be still more strikingly augmented, should circumstances lead to similar deposits of sand and gravel on the sea side of these rocks, thus as it were placing them between two conformable or similarly dipping sets of strata; and if such may be the result in future times, such doubtless it has been in the past, and very great caution is therefore necessary in deciding the relative position of detritic strata of any age, under such circumstances.* Colour, as before remarked, depends too much on accidental or partial causes to be relied upon, except as a local guide: the hydrate of the per-oxyd of iron is for instance yellow, the per-oxyd itself red, hence any modifying cause capable of expelling the water from the hydrate would change its yellow into red; and in like manner, the occurrence of strata of a peculiar character, such as marles, variegated sandstones, sandstones with calcareous beds, in any particular system, cannot be extended into a general test of identity, such forms of mineral matter depending on general laws which have operated not merely at one, but at various epochs: for example, in the parish of Dungiven (see Section, Pl. A. fig 4), in a descending order, marles, variegated sandstone, sandstones with calcareous beds, conglomerates occur, the greater portion of which is manifestly not higher than the carboniferous system, and yet they correspond in a very remarkable manner to the divisions of the new red sandstone system described by M. Elie De Beaumont. Modern geologists have, therefore, felt the necessity of seeking in the relics of organic bodies imbedded in or associated with the strata, other means of identification. The principle on which this method of identification rests is, that the various ages of the earth's surface have been characterised by distinct and peculiar assemblages of organic bodies, or in other words, that there is a relation of conformity between the epochs of mineral and organic change.

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* The inclination of the strata of the Skerries is towards the shore, and a careful observer would therefore possess a clue to the difficulty in that and similar cases.

Important as this new element of geological reasoning unquestionably is, affording as it often does the only clue by which the intricacies of stratification can be unravelled, it must be used with caution, and in strict connexion with mineral structure. Geological reasonings founded on zoological evidence, can only be conclusive, in proportion as the data on which they are founded are comprehensive and correct, implying thereby, not merely the examination and determination of the objects themselves, but also, of the conditions under which they existed. At the present moment it cannot be affirmed that the number of now existing creatures has been ascertained, and still less, their distribution and mutual dependence on each other: if, therefore, the fauna of the present epoch is yet in its infancy, if more extended and systematic dredging on the coasts of these and other countries, may be expected to widen the range of creatures already known, to establish amongst them new and unexpected collocations of species, and to discover other objects of novel form and structure; so in a still higher degree must the fauna of each ancient epoch be considered imperfect, and the examination of every new locality be expected to produce either new species and genera, to extend the range of those already known, or to establish amongst them new modes of grouping. To render then the records of any one zoological epoch, recent or past, perfect, much labour and close investigation are yet required; and until that condition of completeness has been attained numerical relations of comparison can have only a local application, and fossil evidence must be applied with caution to the detailed determination of the stratification of distant countries. Finally, as regards the conjoint consideration of fossil remains, and of the mineral structure of the strata which contain them, the following appear to be reasonable deductions, from an examination of nature as it now is, and therefore applicable in explanation of its past condition:—

First,—The presence of conglomerate or gravel, of sandstone or sand, of slate, shale or clay,—of marle or limestone,—indicates a distinctive peculiarity in the mode of deposit, or in the action of the forces which induced it.

Secondly,—As in the present course of nature, the simultaneous operation in different localities of these varied forces, gives rise to the simultaneous deposit of each and of all these forms of matter; and in like manner, as local alterations in the amount and direction of the forces, have varied the mode of arrangement of those deposits: so may it be inferred that each ancient system of strata included similar forms of detritic matter, and was subject to similar variations in the mode of their arrangement.

Thirdly,—If in those animals now existing, either on dry land or at the bottom of the sea, their habits are adapted to some particular physical conditions of the dry land, or of the sea-bottom at the places where they are found, it may be reasonably assumed that a similar adaptation ought to be traced in those of ancient epochs, and hence that sandstones, shales, and limestones, should exhibit some organic characters peculiar to each.

Fourthly.—If such adaptation be admitted, it is evident that the presence or absence of any one or more of these forms of deposit, must, at the place of observation, influence the amount and character of the organic relics found in that particular geological system; and in consequence that a satisfactory comparison can only be instituted between the fossils of two different localities of the same system, when the same forms of mineral deposit are developed in each. And when such is not the case, that the comparison should be made between the fossils of the sandstones, of the shales, or of the limestones, individually, of one locality, and those of another: and further, that the same rule applies to the comparison of the fossils of different epochs or systems; the fossils of the sandstones of one system being comparable with those of the sandstones of another, the fossils of the shales with those of other shales, and so on;—

a general comparison of all the fossils of any one system, with all the fossils of any other, being efficiently practicable only where the same mineral members are present in each. Such a principle of comparison will, it is true, occasionally restrain the fossil geologist in the course of his deductions; but, at the same time, it will enable him to discern the recurrence at various epochs of similar types of organic existence, and to draw conclusions more sound, as being more conformable to the ordinary analogies of nature. See for example the shales of the silurian and carboniferous systems, and the marly or calcareous shales of the new red sandstone systems of the present illustrations.

This brief summary of what appear to be the true principles of geological comparison and deduction, as regards stratified deposits, is a necessary preliminary to the consideration of the most fitting mode of graphically representing the various groups, or systems of deposits—whether by colours, by signs, or by colours and signs combined.

Two methods naturally present themselves: the first, that of appropriating to each distinct system a distinct colour; the sandstones, shales, and limestones of any one system being all coloured alike, and the differences of their mineral character being expressed by signs: the second, that of appropriating to each form of deposit a peculiar colour, a sandstone, a shale, or a limestone, being coloured the same in whatever formation it may be found, and the formations themselves being distinguished by signs.

It cannot be said that either of these systems has as yet been fairly brought to the test of experience in any extensive map; difficulties, formidable, though not insurmountable, having deterred geologists from seriously entering upon the task of arranging and applying a general system of tints and signs. One of these has been more especially insisted upon—namely, the impossibility of selecting any colours which should, if confined exclusively to particular formations, produce a good pictorial effect on the maps of various countries in which these formations may be distributed in a great variety of modes; "the same colour employed under different conditions, leading to very different optical results—being in perfect harmony when applied to one map, when applied to another, painfully discordant."—(Greenough, Intr. Mem. page 10.) But as Mr.

Greenough also observes—(Intr. Mem. page 87,) "the tints of a geological map speak to the mind as well as to the eye; and the relations of these to one another, must convey clear and definite ideas of the natural relation of the objects which they are employed to represent;"—the objection, therefore, of an occasional defect in harmony, has little more force in this case than it would have if urged against a general system of shading the physical features of the earth's surface; since it is evident that there also, the position of the ranges of mountains, of the lakes and rivers, must sometimes be such as to produce harmony, and at other times to cause an unbalanced and disagreeable effect. The second objection to a definite list of formations and of "uniforms," appropriated to them is, as stated by Mr. Greenough—"because different minds frame different schemes of classification, and enlarge or diminish the groups as their own good pleasure or the nature of the countries represented may suggest;" but this objection having its origin in the custom of each observer endeavouring to represent by colours, the subdivisions of each formation as they occur in his own district, would cease, were signs instead of colours adopted for such sub-divisions.

The Second system,—that of applying a distinct colour to each mineral form of deposit, in whatever formation it may be found, and showing the geological position of the strata by signs, is also subject to the first objection, the occasional want of harmony; but is free, if once clearly laid down from the second. This system has of late been partially adopted; for example, M. De la Beche colours the limestone of the grauwacke, the limestone of the carbonaceous system, and the carboniferous limestone shades of blue, but he carries the system no further; chalk is coloured nearly white, on account of its ordinary hue, green sand green, for the same reason, and yet serpentine is coloured yellow. Mr. Murchison colours the Wenlock, Ludlow, and Aymestry limestones of the Silurian system, and the carboniferous limestone blue of different degrees of intensity, and the old and new red sandstone various tints of reddish brown; but the principle is carried no further. Mr. Greenough observes:—"In the distribution of pigments, I have endeavoured to accommodate the colour of the pigment to that of the substance represented; to apply to substances mineralogically similar, similar tints,—to substances mineralogically dissimilar, dissimilar tints; to place in juxta-position those colours only which would either harmonize or contrast, as the occasion might require, to confine the more opaque colours to those parts of the map which are least charged with engraving; to reserve the most forcible colours for the smaller spaces; to denote marked differences in adjoining rocks by strong opposition of hue."—(Intr. Mem., page 8.) Were all these objects deemed of equal importance, it would be impossible to colour any one map without a revision of the colours to be used, and of their hues of intensity. Without sacrificing principle, it may indeed be possible, so to manage the proportional intensities of the various tints, as to facilitate the discrimination of differences,—but to combine together, in the selection of tints, the consideration of colour, mineral composition and geological formation seems impracticable, without the sacrifice of some one leading principle: hence, in Mr. Greenough's table of colours and signs, the two great divisions of the mountain limestone are coloured blue, the chalk white with horizontal lines, the oolites (sandstones and limestones) tints of yellow; three principles of representation for substances mineralogically similar being thus introduced in the place of one: that of mineral composition in the mountain limestone formation—that of colour in the chalk—and that of mechanical composition in the oolites; notwithstanding that neither of these characters can be considered universally and exclusively peculiar to any one formation: shales and sandstones sometimes predominating over the limestone, in the mountain limestone formation; the white colour, and even the associated siliceous matter (flint), having been found (by Mr. Murchison) to prevail in the mountain limestone of Russia as remarkably as in the chalk of England and Ireland; and finally, the oolitic structure being occasionally present in other formations: so that other geologists proceeding upon similar data, might apply the colours here adopted for one set of strata, to another widely different in geological position, and hence remove to a still greater distance the ultimate determination of a common system of geological graphic language.

The system originally adopted on the Ordnance Survey of Ireland, and now continued, is founded on the second general principle—namely, that each distinct form of mineral deposit should be designated by one generic colour, in whatever geological formation it may occur and however frequently it may be repeated: a map thus coloured, showing, first, where slates, sandstones, limestones, shales or clay occur, which is a useful economical result; and secondly, how often they alternate with or succeed each other, a result of equal scientific value. To reduce this principle to practice would be easy, were all mineral deposits found in their original, unaltered, and undisturbed condition; but this is seldom the case, and when the extent of change under the action of modifying causes amounts to a total metamorphosis in the visible characters of a rock, it is sometimes impossible to determine its original condition; more especially as the peculiarities of metamorphic action have been so little studied, that independent of the evidence of direct passage from the unaltered into the altered rocks, no rules have been established for such determination. To a certain extent most rocks have undergone metamorphic action; the original clay being now slate or shale, the original sand, sandstone; their induration having been effected either by cementation through the deposition of mineral matter from infiltrating fluids; or by induration through the action of heat and pressure; or through the conjoint action of both. Yet in all cases where the original peculiarity of the deposit has not been entirely masked by the subsequent metamorphic action, there can be little difficulty in referring from its present to its former condition; without hesitation, a sandstone will be recognized as sand, and shale as clay. and both as aqueous deposits of the detritus of more ancient rocks; in such cases, therefore, a uniform principle, founded on their original condition, is readily applicable. When however metamorphic action has proceeded so far as it has done in clay slate, it becomes more difficult to bring home to the mind the primary state of the altered deposit, especially in slates not containing as data for argument, the remains of organic bodies. Whilst then, the successive deposits of sands and sandstones, clays and shales, or limestones, are naturally characterised by variations of the same primary colours; it is desirable to adopt a modified colour for those deposits, of which the original appearance has been obliterated, although their original condition can be readily inferred, and hence a tint is adopted for slates differing from that used for clays.

Up to this point, the difficulty of regulating the mode of colouring rocks, so far as regards their original condition, in a general sense, as sedimentary deposits, has been comparatively small; though in the case of slates, some difficulty had begun to be felt, consequent upon metamorphic changes; a source of embarrassment anticipated by Mr. Greenough (Principles, pages 215, 216), and since experienced by those able observers who have recently, in succession, examined and described the rocks of Devonshire; and, it may be added, is still a cause of uncertainty in the geology of the South of Ireland. The question of selection is, however, no longer easy of solution, as regards the colour to be applied to the great system of schists, which embraces all the varieties of gneiss and mica schist, in many of which the mineral characters of sedimentary deposits have been so perfectly obliterated, that they exhibit a union of the crystalline characters of massive igneous rocks, with the distinct stratification of sedimentary deposits. So remarkable a combination of characters has naturally given rise to most opposing opinions as to their origin. They have been associated with granites as part of the original mass of the earth, cooled from fusion: they have been separated from granite and transferred to the sedimentary rocks their crystalline character being ascribed to the metamorphic action of the subjacent granite still left in the class of original rocks: and, thirdly, granite, gneiss, mica schist, &c., have been associated together as being all the results of metamorphic action. Granite, according to this theory, is not considered a part of the nucleus of the earth cooled from an original condition of igneous fluidity, but a crystallized mass obtained from a more perfect metamorphosis of sedimentary deposits. This theory is apparently gaining ground in geology, as it is frequently difficult, if not impossible, to draw a line of demarcation between the metamorphosing and metamorphosed rocks of the preceding theory. In the country to be described in this report, there are many examples of the intimate relation existing between these two classes of rocks—for instance, the mica schist assumes, in several localities, all the appearance of a fine-grained granite, to which has been given the name granitiform mica schist, corresponding to Studer's term gneiss-granite; and as there does not appear at such localities any intruded mass of granite of which the granitiform mica schist might be considered a portion, it seems evident that ordinary mica schist may, under fitting circumstances, pass into granite. Studer's opinions may be here cited as embracing a full view of this theory. He says (Jahrbuch, 1840, page 348), "As we see ordinary fucoid-schist and macigno-sandstone pass into chlorite-slate, serpentine and gabbro, so must we extend the same kind of origin, until further experience has taught us another, to all serpentines and gabbro; and when in other places the same strata are transformed into mica-slate and gneiss, and again in others the gneiss is changed into granite, so shall we also be obliged to consider granite universally as a production of metamorphosis. That the most distinctive granite should principally occur at great depths, at the base or at the nucleus of the crystalline schists will in no way surprise us; such is the position necessarily fitted for the production of the most perfect metamorphosis." Could the natural inference from the last paragraph be adopted, that the degree of metamorphosis was in proportion to the depth, or to the conjoint increase of pressure and of internal heat, the hypogene theory of Lyell would explain the phenomena. Studer, however, proceeds to adduce examples of metamorphosis more remarkable as regards their nature and circumstances—such as the transformation of limestone into talc-slate, and the existence of metamorphosed strata overlying a great depth of other strata entirely unchanged—and then declares that modern chemistry is in explanation of such cases powerless: that elementary bodies may possibly be reducible to still more simple forms, so as to admit of transformation by mutually varying combinations, that some electric polarizing agency may affect a change in the upper strata, whilst the lower are subject only to the deep-seated forces below them. But the succeeding passage, "yet why should the existence of such a law seem restricted to the Alps," must impress on every mind the necessity of more extensive and more detailed inquiries, as to the condition, previous and subsequent to metamorphosis, of stratified deposits which are supposed to have undergone a change so extraordinary, as not to be explicable by any known chemical laws. Perhaps the most minute and interesting observations yet published on this subject, are those contained in the Gæa Norvegica, by Professor Keilhau; and as it is essential to know the effects there described, in order to understand some of the facts which will be brought forward in this work, and to appreciate the principle of colouring which will be adopted, those passages in the first part of the Gæa which is more particularly the work of Keilhau himself, will be quoted, and will show that Keilhau has anticipated most of Studer's opinions, not excepting that in which he asserts the great improbability that any one has yet penetrated below the crust of detritus, stratified and metamorphosed, into the body of the earth itself; "we speak here," he says, "not of the formations of the earliest periods, of the actually original formations, which no one has yet seen." At page 61, the transformation of quartz slate is thus described: "the quartz slate passes into perfect mica schist, or hornblende schist, or into a mixture of both; the quartz, in some parts of these formations is still present, but in others it has so entirely disappeared that nothing is seen except fine scaly mica, and darker green hornblende; at the same time the quartz slate, on approaching the granite rocks, is not always replaced entirely by mica and hornblende schists; in many instances of contact it merely assumes a granular texture."

In studying the varieties of rocks which occur within the boundary of the great mica schist district of Derry, &c., including soft glistening slates, layers of quartz, and various modifications of hornblendic rocks, this passage will often recur to recollection; although the perfectly metamorphosed rock, whether granite or syenite, does not in general come to the surface, so as to be observed, in connexion with these phenomena, —at pages 61 and 62, (Gæa,) the remarkable appearances attendant on such metamorphosis are fully detailed.—"Into the quartz the granite masses have often, as it were, so passed away, that there is no defined boundary between them; but where mica and hornblende occur in sufficient abundance there they assume a gneisose structure, which is strongly contrasted with the distinct granitic structure of the massive rocks,and in these cases there will be found a very distinct line of demarcation between the two formations. Although no actual transition is here effected, the connexion of the granite with the stratified district is not the less intimate; for example, if we pass from the district of the stratified rocks towards that of the sienites, we first meet protruded masses of the latter rocks, consisting essentially of granite, the hornblende having disappeared; and in like manner we meet isolated portions of the same granite lying here and there in the quartz, hornblendic or mica schists, which have no connexion whatever with the main body of the syenite. Should we proceed further, we remark, that the masses, as also the scattered and isolated portions become more frequent and extensive, and at last unite into one connected whole. The scene is now changed: the hornblendic and mica schists appear scattered and isolated in the large mass of the granitic rocks, and as the distance from the boundary increases they diminish more and more, and at length entirely disappear. But to the last, whilst even the faintest rudiments of schist, isolated in the large mass of sienites, remain, their slaty surfaces preserve a perfect parallelism with the slates of the adjoining district, a circumstance as undeniable as it is important, since, as every one sees, it furnishes one of the most powerful arguments against the theory of eruptions.

When isolated portions of granite occur in the quartz schist, the schist in their vicinity is filled with mica and hornblende, and in proportion as such laminar particles become more frequent in them, they are changed into mica or hornblendic schist, lose their regular parallel structure, and are twisted in various ways." And at page 116, it is inferred that as siliceous slates have been gradually assimilated by the metamorphosing process to granite, so may the other primitive schists, gneiss, mica slate, &c. suffer similar transmutations. "That the large masses of granite and syenite are, in all those places where direct observation is possible, almost identically circumstanced in respect to the primitive slates with which they are in contact, as they are in respect to the stratified transition rocks with which they are also sometimes found in contact."

There is another important fact in metamorphosis as regards limestone, noticed at page 64, which should be kept in view when examining beds of limestone associated with mica slate, and considering the modifications they have in part undergone without the alteration of their more essential characteristics as limestones: "somewhat above Egebergs, has Naumann observed the junction of the limestone formation with the granite. At one place are seen conformable, overlying, slightly inclined limestone strata on the massive rocks; but close to this the latter are seen in the form of either dyke-like fragments, or wedge-shaped masses, within the limestone, and the latter similarly situated as regards the granite. This mutual anastomosis is sometimes on so small a scale, that a fragment of the size of the hand exhibits numerous granite veins, crowded through the limestone. The granite within these ramifications appears only slightly modified: it is less red in colour and almost without a trace of mica; but in fragments of only half an inch the felspar crystals are a quarter of an inch long, and between them are many grains of quartz, and not rarely grains of titaniferous iron. The limestone close to the granite is quite flinty, of a greenish grey colour, and finely splintery, as in our "kieselkalk;" but beyond the ramifying veins it is a crystalline granular marble. A general remark may be founded on this, that granite veins very seldom penetrate into pure limestone, but on the contrary, are more frequent, more delicate and more varied in their ramifications, the richer in silica the rocks are with which they come in contact."

The general results of these interesting and minute observations, Keilhau states at page 118.—"An axiom, which acquired authority as its truth and necessity, were brought home to us at almost every step, was this: that contrary to the old opinions, fluidity and solution, in the ordinary sense of the words, are not a necessary condition in order that masses should be in action, that matter should be in motion, and that chemical changes should take place. We ascertained by studying the relations of the granite and porphyry spread through the district and the effects of contact, that the formative power could be effectively exercised even in rock-masses long since consolidated; that widely operating chemical processes could yet be in action within them, the reality of which is entitled to recognition, even though our experience of them is entirely derived in a geological way, more direct observations being impracticable. In comparison to this fundamental law in geology, since we cannot assign it a lesser rank, our further general results will perhaps appear of only subordinate importance. We observed, for example, that the chemically formed rocks or layers of the crust of the earth, were not compounded of heterogeneous crystals brought together irregularly, but through a long continued process had been formed into their present fixed condition, out of masses previously transported, at least in great measure, mechanically, and deposited in a crude state (we speak here not of formations of the earliest periods, not of original formations which as yet no one has seen); that according to their special internal nature they exhibit a tendency to certain fixed external forms, although much depending in this on attendant circumstances. We also found that granite rocks under the same circumstances, were always circumscribed in the same manner: for example, those masses in contact with the hard schists ramified into them producing a tortuous bounding outline; that on the contrary, masses of porphyry and greenstone assumed more rigid forms, and those of limestone had at their line of separation rounded bounding surfaces. To deny the reality of the transformation in consequence of which the altered rocks are found to possess other elements than those contained in their original materials, because we cannot explain such changes by the data of our present chemical knowledge would require us to deny the facts themselves. Here also we learn, that processes which in a mass fitted for the operation had produced or brought to maturity according to some settled type, a definite species of rock, continued, when other heterogeneous masses were brought within their reach or within the sphere of action especially assigned to them, to consume, as it were, every thing which came in their way, and to change the most varied materials into new and important rocks. But on the other hand, data were obtained to prove that this power to metamorphose every thing, seemingly without exception, is not unlimited, as it sometimes encounters difficulties either absolutely or conditionally insurmountable; a striking example of which is the fact that granite does not ramify itself, in the usual manner, into marble; and also, that quartz conglomerates of the sandstone occur within and adjacent to porphyry, where we should the least expect to find them."

If the first theory of crystalline schists were assumed as the true basis of their classification, they should be coloured the same as granite, or as original rocks, a theory no longer tenable. If the second were adopted, granite should be coloured either differently from all other rocks as an underlying igneous rock, or like basalt, both being of decided igneous origin; and the crystalline schists should be coloured of some peculiar tint to be applied to all metamorphic rocks, or of the same tint as that appropriated to their original condition as sedimentary deposits.

On the basis of the third theory, that granite like the crystalline schists is the result of metamorphic action, these schists might be coloured either the same as granite, as having passed through the same process; or different from it, to show that such schists still retain characters sufficiently distinctive to point out their former condition as sedimentary deposits. The deduction of Keilhau, from the observations quoted, especially from the remarkable fact that the laminæ of fragments of schist enveloped in the granite, retain undisturbed their original dip, corresponding to that of the larger and unaffected portions of the adjacent schist, is unfavourable to the eruptive theory of igneous rocks, whilst it supports the idea of some peculiar metamorphic process, probably in part, as he observes, similar to that experimentally explained by Mr. Fox, the substance and structure of the schists having been assimilated to those of the granite, without the intervention of fusion or liquidity : a theory by no means opposed to the metamorphic origin of granite, as such metamorphism may have extended to a point very remote from the present external surface of the granite, and have occurred at a time very distant from the present epoch. Mr. Lyell appears, however, on examining the same country in company with Keilhau, not to reject the theory of eruptions.*

The reasonings and conclusions of Keilhau show that he considers the remarkable phenomena of metamorphosis to take place in consolidated strata, a mode of viewing the subject which still leaves some of them difficult of comprehension; as, for example, the case adduced by Studer, of metamorphosed resting upon unaltered strata. It may, however, be suggested, that some light is thrown on these phenomena by the experiments of Göppert on the modus operandi of petrifaction. Strata, in the state of detritus, must have been penetrated by fluids, which dissolving some of the old and inducing new combinations of elementary substances, a rise of temperature, accompanied by other metamorphosing agents coming into action would produce changes as various as the combinations of substances to be acted upon.

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* 1841.—The Rev. Robert Everest has brought before the Geological Society, equally striking examples of the gradual change, on approaching the granitic centre, of black carbonaceous shales into mica schist, in his journey from Delhi to the frontiers of Little Thibet, through the Himalaya Mountains.

But whatever mode of explanation is adopted, it seems undeniable that according to the observations of Keilhau, siliceous schists of the transition period have been metamorphosed into mica schist and gneiss, and that the latter have been changed to granite; and very probable according to those of Studer, and others, that strata of the oolitic and cretaceous periods have undergone similar transmutations into mica and hornblendic schists; a theory which Mr. Hamilton, Secretary of the Geological Society of London, has still more recently proposed to apply to the mica schist of Asia Minor, examined by him and Mr. Strickland. It is right also to state that more than ten years ago Mr. J. Bryce of Belfast was inclined to consider the mica schists, and red sandstones of the neighbourhood of Cushendall, as associated together; and although in that instance appearances may have deceived him, the opinion was evidently not so extravagant as it was then considered. Gneiss and mica schist, therefore, are not necessarily the most ancient of stratified rocks; but on the contrary, may be found associated with the strata of various geological epochs, and hence the colour appropriated to them must either be that of the original sedimentary deposits from which they have been altered, or must partake of some modification calculated to express their metamorphic condition. The latter appears the safest principle: a distinct colour therefore, or at least a peculiar tint, will be appropriated to the crystalline schists.

The rocks, taken in classes, yet to be considered, are :—1st, Granite, including syenite. 2nd, Greenstones and porphyries. 3rd, Basalt.—Mr. Murchison, and after him Mr. Griffith, has coloured the underlying and overlying rocks, (hitherto denominated igneous) with the same tint. This, however, seems objectionable, as in the case of basalt a relation can be traced between it and other volcanic erupted rocks, whilst in that of granite, considered as a metamorphic rock, such relation does not exist: it seems therefore, desirable, to use distinct colours for granites and for trap rocks. Nor is it less desirable to distinguish granites from greenstones and porphyries. Both, it is true, have undergone metamorphic action, but in very different degrees; in granite, it has gone so far as to obliterate all traces of original structure; in greenstone, it has extended so far as to obliterate, partially or entirely, the planes of stratification, but it has left in position, external appearance, and partly in internal structure, evidences of original condition though not sufficiently strong to determine the precise nature of that condition. Further, if granite be considered a metamorphosed sedimentary rock, the stratified rocks to which it has most analogy are the various crystalline schists; and in like manner, greenstones have a strong analogy to basalts: it is desirable then to consider them belonging to distinct types. A distinction of colour, aided by signs, will facilitate the exhibition of these phenomena of metamorphosis, which must remain obscure until it has been ascertained by careful observation, whether there are definite characters in the supposed metamorphosing rocks, by which the general nature of the metamorphosed rock may be inferred. For example, in passing over the red sandstone district of Slieve Gallion to the granite, the steps of the transition are through a red porphyry into a red syenitic granite; whilst in another section, the metamorphic portion is a hornblendic rock, porphyritic by crystals of hornblende, and the granite less red and sometimes slightly micaceous.

Scale of Colours, according to preceding Principles:—

Granite, ...	Red.	
Basalt, ...	Green.	
Metamorphic crystalline schists, granitic type, gneiss, mica schist, &c.	Red.	Differing in tint from granite.
Metamorphic rocks, in which planes of true stratification cannot be distinguished, such as greenstones and porphyries, and crystalline schists of a hornblendic type	Green.	Differing in tint from basalt.
Slates, the composition and structure of which indicate their origin . .	Modification of brown.	
Shales and clay, ...	Brown.	
Sandstone, ...	Yellow.	
Limestone, ...	Blue.	

The geological epochs will be distinguished by signs and numbers, adopting the following epochs :—

Anterior to Silurian—without specific number.

1. Silurian.
2. Devonian, or old red sandstone.
3. Carboniferous.
4. Poikilitic, or new red sandstone; including zechstein and trias groups.
5. Oolitic.
6. Cretaceous.
7. Tertiary.

Detritic, by the small letter (*d*).

The same letters as heretofore will be used, to designate each form of mineral deposit, viz :—

G. Granite : and with a specific letter, granitic compounds.
H. Hornblende : and with a specific letter, all metamorphic compounds of a hornblendic type.
T. Basalt.
S. Slate.
C. Shale and Clay.
A. Sand and Sandstone.
L. Limestone.

The figure before each letter will signify the order of the deposit : the small figure after it the subdivision of that deposit, viz. :—

1 *S.* Slate, of the Silurian epoch.
3 L^2. Second subdivision of the carboniferous Limestone, &c. &c.

Other occasional combinations will be explained as used, and signs will be adopted on the map to distinguish the several forms of metamorphic agency.

CHAPTER II.

REVIEW OF THE WORKS OF PRECEDING WRITERS.

LITTLE of an early date, has been recorded on the geology of this country. Passing by for the present, notices on the Giant's Causeway, which appeared in the early volumes of the Philosophical Transactions, one of the first papers which can be incidentally referred to geology is a communication made to the Royal Society by the Archbishop* of Dublin, in the year 1708.

This paper explains the manner of manuring lands, by sea shells, as practised in the counties of Londonderry and Donegal. "Marl is not used that I have observed in the north, but about the sea-side the great manure is shells: any one that will look into the map, will see how the bay of London, commonly called Lough-Foyle, lies. Towards the eastern part of it, there lie several eminences that hardly appear at low-water; these are made of shells of sea-fish of all sorts, more particularly of perriwinkle, cockles, limpet, &c. The countrymen come with boats at low-water, and carry loads of these shells away:" an application of the shell banks or islands, which has been continued to the present day.

The Archbishop proceeds, "almost about the bay of Londonderry, if you dig a foot or two it yields shells, and whole banks are made up of them; but these, through more entire than such as are brought out of the shell island, are not so profitable for manure." I observed in a place near Newtown-Lamavady, about two miles from the sea, a bed of shells such as lie on the strand; the place was covered with a scurf of wet spongy earth about a foot thick; the country people used the shells, but they were not reckoned so good as those that are found in the sea or near it."

Here, then, is a distinct notice of one of the tertiary deposits which will hereafter be described; but whether it was identical in position with any of those which can yet be studied, or was in course of time entirely worked out and obliterated, cannot now be determined; it may however be conjectured, that as the shells in the newer pliocene deposits of this country are not sufficiently abundant to be profitably used as manure, though the calcareous clay in which they are imbedded might occasionally be so applied with advantage, the shells mentioned by the Archbishop, were probably related to more recent shelly deposits such as that of Portrush, first noticed by Mr. Smith of Jordan Hill. Another passage in this paper, though foreign to the present subject, deserves to be quoted, "the inconveniences of burning the turf are first, that such burning defiles the air and causeth rain and wind;" the Archbishop anticipating Mr. Espy in one of the practical illustrations of his Theory of Storms.

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* William King, Bishop of Derry 1691; Archbishop of Dublin 1702.

1725.—In the Anthologia Hibernica, for January, 1794, the design of Dr. Nicolson, Bishop of Derry, to write the Natural History of his diocese, is referred to by a writer, under the signature D. By his statement it appears that the Bishop requested his clergy to make collections in their respective parishes, and that many complied, particularly the Rev. Robert Innes, Rector of Magilligan, who published in London, A.D. 1732, seven letters addressed to his Lordship; three of these were republished in the Anthologia: the first dated Magilligan, June 2nd, 1725. It commences by extolling the parish as a botanical region; "I believe," he observes, "this parish could afford as good a collection of native herbs, as any one place in the three kingdoms;" and after enumerating some of them, adds, "in a word, it is the physic-garden for the Irish doctors both far and near: the reason is the great variety of soil;" a character for botanical richness which the locality still preserves. The author also records some of the zoological rarities, such for example as a large pinna; "the fish is very scarce, and a non-descript; several of the shells are nine inches long, and six inches at the broad end, and scarce half-an-inch at the other." More than a century has elapsed, and this coast continues a good locality for pinna fragilis;* to obtain the fish in the valves they must be dredged up from deep water.

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* P. pectinata: this appears to be the common species of the Irish coast, being found in abundance both in the north and south; the ribs are more or less spined in the young shells, but in the old the ribs are smooth; it is fragile when young, but occasionally more massive, approximating to P. ingens; it attains a length of eleven inches.

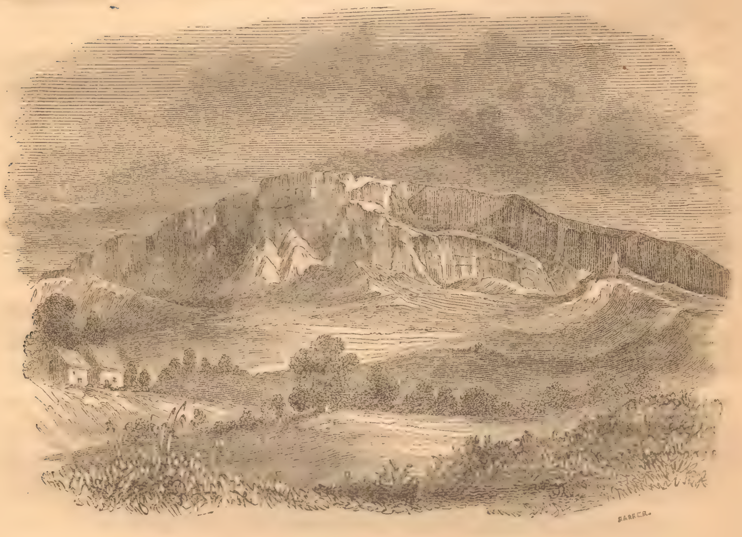
The geological remarks refer entirely to what the author considers proofs of diluvial action in the parish of Magilligan. "That this land was formerly sea," he says "I think, there is sufficient reason to believe, for along at the foot of the mountain, and all the coast, is the old bank to be seen, to which the sea hath formerly flowed, at the foot of which every where is sea-sand and shells to be dug up. And the Giant's Grave, another curiosity in this place, proves it; it is a mile and a half long: one limb of him lies at Balspoint, at the mouth of the river Roe, passeth by Mrs. Gage's house, and under my house, and along the high way, a quarter of a mile farther; it is a ridge of stones, such as the sea throws up on beaches, mixed with shells and sand; besides, near my house, a mile from the sea, at the foot of the grave, is the quicksand raised at the second spade, and at the digging seems to be a small shell, but when some days in the air, turns to dust. The other limb of the giant, the Irish fable makes lost in a battle—but of late they have discovered some more of him, by a shell-bank under Ballycastle Orchard, two miles now from the sea up the river Roe, and another bank of shells more than a mile farther up at Skrieve, near the road from Newtown to Coleraine. The low land of Magilligan is divided into ridges (or as we call them, dryms,) of sand, from one hundred to five hundred yards broad, highest in the middle, and sloping on each side, to marshy ground (which we call misks), commonly as broad as the dryms: the dryms are generally from six to twelve feet higher than the misks; but on the north side, next the ocean, the dryms and misks are narrower, and some of the dryms thirty or forty feet higher than the misks. Both the dryms and misks run parallel almost—first a drym, then a misk, interchangeably, the whole length of the parish for five miles: the length of the dryms runs from east to west, from the mountain to Lough-Foyle, and is in most places two miles long, in some places less, in some more: only for half-a-mile, next the mountain, it is all one bog and level. The cause of this and of the lands settling in the bay, cannot otherwise be accounted for, but by the general deluge; for I am fully persuaded that the rivers that fall into Lough-Foyle could not, with all the sand and mud that they carried down in floods, form so large a piece of country as in this parish, and Meroe, and the flats of Bellekelly, besides many other places; as to Magilligan it is so far from adding to it, that it bears no proportion to the land, and is every year taking from it on Lough-Foyle side; there are men alive who know the land to have lost one hundred yards, and if we can make anything of Irish fables, the flats of Lough-Foyle, which extend in some places a full league, have been formerly part of this land."

It is unnecessary to repeat in detail, the author's speculation on the mode in which these diluvial effects were brought about; the retiring waters of the deluge first sweeping down mud and earth, and then forcing their way through the accumulated mass in as many channels as there are now misks: nor to do more than mention the other proofs, in our author's estimation, of the workings of a deluge; the continued heap of stones and rocks tumbled down for more than half the mountain, and one rock in particular left standing upon the side of the precipice, the remainder of a huge quantity of rocks tumbled down below it.—"It is about twenty-eight feet in height, about six yards about, with natural seams in it, not very well cemented. No art of the Irish could place it there: it is called the Merog, or Finger-stone."

No. 1.

The very constitution of this and other similar fragments, and of those large masses which have slipped down, and now form the under-cliff of Ben Evenagh, is inconsistent with the idea of diluvial action, as the cause of their present form and position, and is easily referred to more simple agencies which will hereafter be explained.

No. 2.



These notices, though faulty in theory, are valuable in reference to facts. The shell-bank at Skrieve (Streeve), on the road from Newtown to Coleraine, belonged, it is probable, to the newer pliocene epoch: relics of a deposit of calcareous clay of that age, containing shells, being still visible at a considerable elevation, on the road from Newtown, and in isolated patches in other parts of the country. This deposit of calcareous mud, containing fragments of chalk and basalt, together with shells, marks a period when the sea stood at a level, so much higher as to connect it with some portions of the now inland basaltic cliffs: the shells are of two descriptions: first, fragments of the strong hinge of Cyprina islandica, the shells of which must have been shattered by moving from a considerable distance, none being perfect, whereas some at least would have been so had they been merely broken up by the tidal waves beating on the shore or bank: second, perfect shells, such as terebra turritella, and the delicate nucula oblonga; not however, occurring together, but occupying distinct localities. At present, it is only necessary to remark, that the preservation of the shells of the nucula, immersed in clay with both valves perfect, often adherent to each other and closed, indicates tranquil deposition; whilst the analogy of the closely allied species, nucula minuta, which has been dredged up from deep water (10 to 15 fathoms) in Belfast Lough, indicates the probability that such deposition took place under a considerable body of water, and hence that the surface level of the sea was at that time related to a point of the land or cliffs higher in some places, by 300 feet than its present level. The other detritic deposit with shells, namely, the Giant's Grave, is evidently a raised beach of a more recent date. The subsequent growth of the bog in the misky ground, and of the forest of oaks and yews, the trunks of which are dug out of it, are also recorded by Mr. Innes, and are progressive events of much philosophic interest.

His second letter, August 3rd, 1725, adds nothing of importance to the first, and this notice may be concluded by remarking that Mr. Innes took a simple view of the mode of diluvial action. He compared the retiring waters to those of a great tide: "and if we compute, by the account we have of the Deluge, we shall find the current of waters was very great: for we find in sixty days, from the time that the tops of the mountains began to appear, the waters ran off the face of the ground; which by a moderate allowance, reckoning the mountains to be a mile and a half high, though there are mountains much higher, comes to decrease about forty-three yards a day. Now our spring-tides here, unless in storms, scarce rise four yards, which running out in six hours, makes but sixteen yards a day: so that the current of the waters at the Deluge, when within the mountains, must be near triple as swift as our spring-tides."

1786.—This country was visited by John Whitehurst, and his observations are recorded in the 19th chapter of his work: "On the Original State and Formation of the Earth." He begins his notice at Gorestown, in the county of Armagh, where shafts had been sunk in search of coal without success. This led him to examine the lower strata, and finding them to consist of a lightish blue calcareous shale, intermixed with marine shells, entrochi, &c., and likewise with some nodules of ironstone, in which were inclosed fragments of shells retaining their native testaceous matter, he concluded that the shale was a stratum of decomposed limestone, and the prospect of coal unfavourable. He next visited Drumglass colliery, Tyrone, the sinking of which had then passed through—

	Ft.	In.
1st. Clay and Rubble Stones	48	0
2nd. Soft argillaceous Stones	30	0
3rd. Bind, or argillaceous Clay . . .	35	0
4th. Shale	15	0
5th. Coal	4	6
6th. Argillaceous Stone, not cut through .		
	132	6

One seam only of coal therefore had at that time been worked, at a depth of 132 feet 6 inches. The white limestone, N.E. of Moneymore, and again at Dunluce Castle, he notices as "so similar in appearance to a stratum of chalk, that I had every reason to suppose it a chalk stratum fully concreted, or become a perfect limestone."—He observed also that it contained an immense quantity of chert, and some few marine shells of the belemnite order. These remarks were judicious as were those on the basalt which he noticed at Maghera, on the road to Garvagh, and in the neighbourhood of Coleraine, and considered fragments of lavas scattered over the lands, and in situ on the roads to Portrush strand, at the Causeway, and at Ballycastle. The extent of the formation he thus conjectures: "the great analogy between the colour of the soil near Coleraine, and the parts adjacent, seems to indicate that a vast torrent of lava, has flowed from the north of Ireland, southward, since it may be presumed, that similar appearances have arose from similar causes, viz. decomposed lava: therefore, since the colour extends to the distance of twenty or thirty miles towards the south, and nearly as far east and west, we may thence infer, what an extensive tract of ground has been covered by liquid fire, namely, twenty or thirty miles from north to south; and nearly as far from west towards the east, where it terminates at

Ballycastle upon a stratum of white limestone, and at which place the measures totally change to different denominations, viz.—argillaceous stone, clay, and coal."

Portrush strand is represented as "exhibiting an awful wreck of the terraqueous globe, consisting altogether of immense masses of black lava, so extremely replete with bladder lobes, and so void of extraneous matter, that it perfectly resembles the scoria of iron, and therefore leaves not the least doubt of its being a volcanic production."

It is remarkable that Whitehurst makes no mention of the chalk or white rocks of Portrush: the lava, he traces from Portrush strand to the Causeway. His conception of the Giant's Causeway was accurate: "it is situated at the foot of a stupendous cliff, the elevation whereof is not apparently less than five or six hundred feet perpendicular above the Atlantic Ocean; and yet the whole of this cliff consists of one entire mass, composed of different strata of lava; for it is not apparently the effects of one eruption, but of many successive convulsions." After explaining his views of the cause of the columnar structure he proceeds to meet objections to the eruptive theory: "but notwithstanding the preceding observations have some tendency to unfold the original cause of basaltes, some doubts may nevertheless arise, with respect to the origin of the Giant's Causeway, and its adjacent mountains: "since no visible crater, nor the least vestige of an extinguished volcano are now remaining, except the substances before mentioned. from whence such immense torrents could have flowed, as are now spread over so great a part of the north of Ireland. These circumstances render it necessary to observe, that whoever attentively views and considers these romantic cliffs, together with the exterior appearances of that mountainous cliff, will, I presume, soon discover sufficient cause to conclude, that the crater from whence that melted matter flowed, together with an immense tract of land towards the north, have been absolutely sunk and swallowed up into the earth, at some remote period of time, and became the bottom of the Atlantic Ocean: a period indeed much beyond the reach of any historical monument, or even of tradition itself. But though it does not appear that any human testimony or record has been handed down to us concerning such a tremendous event, yet the history of that fatal catastrophe is faithfully recorded in the book of nature, and in language and characters equally intelligible to all nations, therefore will not admit of a misinterpretation: I mean those stupendous cliffs which environ a part of the Atlantic Ocean." These observations are valuable as conveying the author's opinion that the great mass of basalt was formed from successive flows, the result of successive convulsions. To enter on the speculations by which it is attempted to connect these phenomena, the formation of bogs, and the casual covering up of various relics of the ancient inhabitants of Ireland with the deluge, would be waste of time since the most ardent lover of ancient recollections would hesitate to ascribe with Whitehurst the cap or crown of gold found ten feet below the surface of a bog in Tipperary, in the year 1692, to antediluvian persons or times, whether the deluge was Noachian or that of Deucalion.

1790.—In this year the Rev. William Hamilton, B.D., M.R.I.A., published his Letters on the Northern Coast of the County of Antrim, and on the "Natural History of the Basaltes and its attendant Fossils in the Northern Counties of Ireland." They are written in a simple agreeable style, and contain of fact and of reasoning much which is interesting to the geologist. The author advocates at considerable length the volcanic origin of the basaltes in opposition to the theory of aqueous deposition, which at that time had many advocates. He prefaces his account of the Causeway by a history of the several attempts made to describe or to illustrate that great natural phenomenon, of which one of the most amusing was a general sketch of the coast near the Causeway, made at the request of Dr. Thomas Molleneux for the Dublin Society, an engraving of which was published under the following title:—

> "A true Prospect of the Giant's Causeway, near Bangor Head, taken from the North West, by Edward Sandys, A.D., 1696, at the expense of the Dublin Society.
>
> Right Honourable Sir Cecil Week, Knight, President.
> Reverend Dr. Ashe, Bishop of Cloyne, } Vice Presidents."
> William Molleneux, Esq. }

In this *true* prospect the artist revelled in all the extravagancies of an exuberant imagination: some of the pillars he clothed with luxuriant branches, so as to skirt "the wild and rocky bay of Port Nosser" with the gay exhibition of stately forest trees; and from the rude and broken fragments of the back ground he called into being comfortable dwelling houses, the chimneys of which were formed of detached pillars of basalt These efforts to embellish the beauty and magnificence of nature resemble those of a writer on American scenery, who considering the Falls of Niagara deficient in sublimity, introduced tumbling over the cataract huge buffaloes: like the trees of the Causeway they were creatures of imagination.

Mr. Hamilton formed an accurate conception of the basaltic precipices in the vicinity of the Causeway, which he describes as alternations of columnar and amorphous basalt; for "though there are but two complete ranges of pillars visible in any of the promontories, yet it is not improbable that there may be many more in succession, at various depths under ground; and this opinion is confirmed by columnar marks which can be traced in several rocks that lie in the sea. The Causeway itself is situated at the base of one of these capes, on the level of the beach, and appears as part of a columnar bed that has been accidentally stripped and washed during a long course of years by rains and the waves of the ocean." The succession of Cape Pleaskin is thus given:

	Feet
1. Summit; irregular basalts, shivered and cracked at the surface	12
2. Perpendicular range of gross pillars, containing air-holes	60
3. Gross bed of rude basaltes, showing marks of a tendency towards forms resembling an imperfect crystallization	60
4. Second range of regular pillars, neat and divided into joints	40
5. Bed of red argillaceous ochre, on which the second range of pillars rests	22
6. A thin course of iron-ore amid the bed of ochre	
7. Soft argillaceous stone, of various colours, and a mottled appearance, friable, and resembling a variety of steatites	
8. Succession of five or six gross beds of table basaltes, between which thin strata of ochre and other substances occur	180
	374

The beds of ochre associated with the basalt and the alternations of columnar and amorphous forms are evidences of successive changes and epochs of formations; it will be useful, therefore, for the future estimation of the subject, to follow Mr. Hamilton a little further. "Ochres of several colours prevail amid the basaltic beds, through different parts of the country. The predominant colour is red, varying from a dull ferrugineous hue to the intensity of the vermillion; there is much argill generally intermixed with these calces of iron; instances, however, occur, where they are sufficiently pure to answer for the purposes of coarse paint. The capes of Bengore, and other similar precipices of the country, exhibit most of the varieties of these ochres at a single view" (page 83). "Those extensive beds of red ochre which abound amongst our basaltes, are supposed to result from an iron earth, reduced to this state of a calx by the long-continued and powerful action of heat; for such a change may be produced on iron in our common furnaces, provided there be a sufficient afflux of fresh air, and the basalt itself, in such circumstances, is easily reduceable to an impure ochre, exactly similar to that found in the semi-circular bays of Bengore; this phenomenon is also observed to take place in the present living volcanoes, particularly within their craters, and is therefore held to afford a presumptive argument of the long-continued action of fire in the neighbourhood of basaltes."

The occurrence of ochre indicates, therefore, in the opinion of Mr. Hamilton, the decomposition of basalt, and its alternation with beds of unaltered basalt the decomposition of several successive layers: its frequent induration into a substance resembling jasper proves that the covering body was poured upon it in a state of igneous fusion; such beds therefore would on this principle afford data for estimating the number of successive basaltic flows, and the relative quantity of matter which resulted from each: this subject will be again referred to, and Mr. Hamilton's remarks on the various forms of basaltic deposits, and on the effects of contact on the limestone, flints, &c., more particularly noticed. The boundary of the chalk district is sketched with accuracy. "The northern coast of Antrim seems to have been originally a compact body of limestone rock, considerably higher than the present level of the sea, over which at some later period, extensive bodies of vitrifiable stone have been superinduced, in a state of softness. The original calcareous stratum appears to be very much deranged and interrupted by these incumbent masses; in some places it is depressed greatly below its ancient level; after a short space one may see it borne down to the water's edge, and can trace it under the surface of the sea; by and by it dips entirely, and seems irretrievably lost under the superior mass;

again, however, after a temporary depression it emerges, and with a similar variation recovers its original height. In this manner, and with such repeated vicissitudes of elevation and depression, it pursues a course of fifty miles along this northern coast, from the length of Carrickfergus on the east, to Lough Foyle on the west. The southern boundary of the chalky limestone, which is peculiar to this part of Ireland, may be traced at intervals through a space of about seventy miles within the county; from the Whitehead on Carrickfergus Bay, until the circuit is completed under the precipice called Solomon's Porch, at the entrance of Lough Foyle. The neighbourhood of Belfast, in the County of Antrim; of Moira, in Down; of Stewartstown, and Coagh in Tyrone; and of Moneymore, Dungiven, and Newtown Limavady, in Derry, will afford instances whereby its course may be traced with tolerable accuracy. Within this large circuit of 120 miles, few substances occur except either the columnar or unformed basaltes, and the fossils usually connected with them; without the circuit, however, fossils of a new and different character soon make their appearance through every part of the country:" a statement of the extent of the Chalk Basin, to which little if any addition can even now be made. The remarkable depressions of the chalk, which cause an appearance of want of continuity in the basin are supposed to be connected in the preceding extract, and in the following, with the appearance of the basalt, and more especially with that of columnar basalt; "the chalky cliffs may be discovered a little eastward from Portrush; after a short course they are suddenly depressed to the water's edge under Dunluce Castle, and soon after lost entirely in passing near the basalt hill of Dunluce, whose craigs, at a little distance from the sea, are all columnar. At the River Bush the limestone recovers, and skims for a moment along the level of the sea, but immediately vanishes on approaching toward the great promontory of Bengor, which abounds in every part with pillars of basaltes; under this it is completely lost for the space of more than three miles. Eastward from thence, beyond Dunseverick Castle, it again emerges, and rising to a considerable height, forms a beautiful barrier to White Park Bay and the Ballintoy shore. After this it suffers a temporary depression near the basalt hill of Knockfoghy, and then ranges along the coast as far as Ballycastle Bay; Fairhead, towering magnificently with its massive columns of basaltes, again exterminates it, and once more it rises to the eastward, pursuing its devious course, and forming on the Glenarm shore, a line of coast the most fantastically beautiful that can be imagined." Mr. Hamilton notices the correspondence in its chalk and basalt, of the Island of Raghery or Rathlin with the main shore, and also states that the "heterogeneous mass of sandstone, coals, iron ore, &c., the substances which form the eastern side of Ballycastle Bay, and appear quite different from the common fossils of the country, may be also traced directly opposite, running under Raghery with circumstances which almost demonstrably ascertain it to be a continuation of the same general strata." This variation of the apparent level of the chalk, or in other words, the frequent and sudden depression of its surface, is deserving of attention. Mr. Hamilton connects it as cause and effect with the overlying, and specially with the columnar basalt, but in what manner the pillars of Fairhead "exterminated" the chalk he does not explain. If the depressions are the result of so many faults or dislocations connected with the basaltic agencies as contemporaneous phenomena, they differ in character and cause from the large gaps which separate the several portions of the chalk in the inland parts of Derry, and are the result of disintegration and denudation. In the latter cases, as in Ben Evenagh, the work of destruction has been facilitated by the soft or easily decomposed nature of the subjacent strata, and even in the former such depressions may have been aided by a similar cause, the lias cropping out at Ballintoy, and at Portrush though there sufficiently indurated by contact with igneous rocks to resist the progress of destruction. This remarkable condition of the lias and its contained fossils, escaped Mr. Hamilton's notice, although several of his letters are dated from Portrush; and it is probable, therefore, that like Whitehurst, he considered the whole of the promontory basalt.

January 2nd, 1808.—The letter of this date, addressed by the Rev. William Richardson, D.D., Rector of Clonfecle, to Humphry Davy, Esq., Sec. R.S., on the alterations that have taken place in the structure of rocks, on the surface of the basaltic country in the counties of Derry and Antrim, was read before the Royal Society on the 17th March of the same year.

Dr. Richardson describes the promontory of Bengore in considerable detail, enumerating sixteen strata or layers, (of which three are ochre,) and pointing out the characteristic features and beauties of each. His principal object was to show that the several layers of the great basaltic formation and their subjacent strata, were once continuous, and subsequently broken up into their present detached and irregular condition by the action of some powerful force which at once detached and utterly swept away large masses of the strata. Taking this view of the subject, Dr. Richardson connects together as one phenomenon the irregularities of the basaltic surface on the northern coast, and the deep indentations of the strata, secondary and basaltic, of the inland cliffs. Of the latter he says: "the removed parts of the limestone (or chalk) stratum on the west side of our area have shared the same fate, for where the chain of mountains extending from Magilligan Rock to Bienbraddoch, is interrupted by vallies at Stradreagh, Drumrommer, and Ballyness, it is obvious that the limestone stratum was once continuous to the high points where it shows itself in Keady, and the mountains on each side; its thickness, too, wherever we can try it, is very great; yet this stratum, which in its entire state must have spread like a roof far above the present surface of these valleys, (which are now sunk deep into the schistose substratum,) has not left a particle of its debris behind, nor is a single lump of white limestone to be found, until we come to the quarries, that is, to the edge of the solid untouched stratum;" and of the former, "after these proofs that so many (and I might proceed to the rest) of our detached hummocks are in their construction and materials similar to, and connected with, the main consolidated masses of which our country is formed, I think it will scarcely be asserted that these hummocks were originally formed solitary and separate as they now stand, but rather that they were once parts of that vast whole, and left behind in their present form upon the removal of the contiguous portions of their strata, by some powerful agent, of whose operations and modes of acting we have hitherto obtained little knowledge." It is evident, from these remarks, that Dr. Richardson did not admit as sufficient to explain the phenomena, either those ordinary causes of wear and tear which are still seen in action wearing down the substance and modifying the form of the sea coast, or that great and extraordinary cause. the Deluge, which so many consider the only efficient cause of such destruction. The Rev. W. Conybeare, Trans. Geol. Society, vol. iii. p. 132, observes on this point, "the general appearances he describes are common, it should be remarked, to the valleys of all countries composed of nearly horizontal strata; but one phenomenon, as stated by him, seems almost peculiar to Antrim, namely, that the materials so removed have been entirely carried off, leaving no traces behind them. This circumstance seems to incline Dr. Richardson to consider the agent which has acted in the manner described, as some unknown and undiscoverable cause, and to hesitate in receiving the common and surely probable opinion which regards diluvial currents as presenting a satisfactory solution; but it must be remembered that the solitary instances he adduces can never weigh against the great majority of cases in which the fragments of the rocks so destroyed, not only occur in abundance where they might be expected, but exhibit the most unequivocal marks of their having experienced the action of agitated waters. It is surely more philosophical to suppose that the violence of the currents has swept away the debris of the Antrim excavations into Lough Neagh on the one side, and into the sea on the other, than that the excavations owe their origin to some unknown cause, distinct from that which appears to have produced all others." To call in an unknown cause in order to explain phenomena explicable on principles known and understood, is assuredly unphilosophical, and yet Dr. Richardson may be excused for hesitating to admit the efficiency of diluvial action. Lough Neagh, itself apparently the result of a great crack and subsidence of the strata, though it attains a depth of ninety feet in one point of the line of subsidence, is generally shallow, and could scarcely have received so great a mass of removed matter. The depression of Lough Neagh and the columnar basalt which appears at Shanes Castle correspond with the great depression of the chalk at the Causeway, and it is therefore very probable that dislocations and depressions of the strata may in this portion of the system have contributed towards the existing irregularities; whilst along the western face of the chalk and basaltic escarpment, the bay-like form of the excavations, and the presence of tertiary deposits, more than 200 feet above the present sea level, containing fragments of chalk and flints mixed with marine shells, partly of still existing species and partly of one (probably) extinct species, point to the long-continued action of a cause similar to that which now by slow degrees undermines, wears down, and removes the rocks of the present sea coast: Dr. Richardson's hesitation then was at the least natural and reasonable, and although the matter will be brought again under consideration in following the course of the chalk escarpment, it seemed just to set before the reader (though in anticipation) his views of the subject as those of the first person who distinctly noticed the phenomenon and its difficulties in a portion of country where this class of denudation is exhibited in a more than usually striking and characteristic form; nor should it be overlooked, that the same phenomenon thus noticed by Dr. Richardson is even more forcibly exhibited by the great mica-schist formation, the wear and tear of which, as exhibited in its broken ridges discontinued for miles, display a far greater amount of denudation prior to the deposition of the secondary rocks than any which has taken place subsequent to it.

As a geological fact, Dr. Richardson noticed the apparent continuation of the chalk in Seafin and Moneyneeny, though manifested only by the white rubble immediately below the basaltic façade. This appearance has recently given rise to some unsuccessful trials to find the chalk, the want of lime being much felt in the neighbouring uplands: it appeared to be the ultimate thinning out of the stratum.

1799.—The discovery of organic remains in a rock considered a species of basalt, naturally excited attention, and was appealed to by the advocates of aqueous deposition as a powerful argument in their favour. Kirwan in his Essays, adduces several instances of basalt overlying rocks containing fossils, such as limestone, coal, &c., but though not without weight as regarded the controversy, they were so far within the limits of explanation on the volcanic theory as to furnish only inconclusive argument against it: the volcanist might with Dolomien, be embarrassed in endeavouring to discover whence the lava had issued which, as trap or basalt, he saw covering a limestone abounding in shells, and yet remain unshaken in his belief that such trap or basalt had originally been a lava. If, however, the Neptunist could show him organic remains as a constituent of the basalt itself, how could he any longer resist a conviction of its aqueous origin: Kirwan, at least, appears so to have thought, and quotes (p. 251) an extract from Ann. Chy. 1794, to the effect that "Bruckenman found muscle shells, ammonites, and corallites, in basalt of the pretended extinct volcanoes of France;" and then (p. 252) states in a note, "Dr. Richardson lately discovered, and showed me, shells in the basalt of Ballycastle." Though there is here a mistake as to the locality, which should have been Portrush, not Ballycastle, the remark proves that Dr. Richardson had made this very interesting discovery in or before the year 1799; nor is it surprising that such conclusions should have been drawn from it at a time when the theory and circumstances of metamorphic action were so little understood.

1802.—Kirwan again notices (Trans. R. Irish Acad.) in his observations on the proofs of the Huttonian Theory of the Earth adduced by Sir James Hall, Bart., this supposed presence of organic remains in basalt, still labouring under the same mistake, as to the precise nature or locality of the stone itself." "I must further add, that the upright state in which many of them exist, for instance the basaltic pillars of Staffa, and of the Giant's Causeway, and of many other countries, the base they rest on, sometimes granite, sometimes gneiss, sometimes coal or limestone, and the total absence of all signs of the operations of fire, forbid us to entertain any doubt of their production in the moist way, nay, the College of Dublin now possesses fragments of basaltic pillars in which marine shells are imbedded; if such evidence can be resisted, it is in vain to seek for greater. This transmutation, under the impulse of theory, of fragments of a laminar or schistose rock into fragments of basaltic pillars, is curious and instructive. That Kirwan's fragments actually belonged to the rock of Portrush, is manifest from the words of Dr. Richardson, who in referring to them, 1803, Trans. R. Irish Ac. "Accounts of the Whynn Dykes in the neighbourhood of the Giant's Causeway, Ballycastle, and Belfast, in a Letter to the Bishop of Dromore," read 1802, says, "this property, possessed by some varieties of our basalt, and other circumstances attending them, as for instance that some of our prismatic basalt in their strata, abound with marine exuviæ, shells and impressions of cornua ammonis, while others columnar and prismatic but not articulated, and others columnar prismatic and articulated, contain cavities full of fresh water to the amount of a thimble full; all these facts have hitherto escaped notice. The nature of this stone is, I know, not yet fully ascertained. Sir Joseph Banks informs me that the specimens I sent to him are pronounced by his friends not to be generic or legitimate basaltes. An eminent Scotch naturalist, who visited the spot last summer, I am told, asserts this stone to be chert petrosilex, or schistus. On the other side, Mr. Kirwan, to whom I gave specimens, asserts in a late publication that it is basalt; our ingenious Mr. Higgins is of the same opinion, and the celebrated Professor Pictet of Geneva, who did me the honour of a visit last summer, considers it to be basalt containing a greater portion of silex than usual; I believe Mons. Pictet is right."

1802.—A juster view of the matter was taken by Playfair (Illustrations, page 286): "another fact which has been much insisted on of late, in proof of the aqueous formation of basaltic rocks is, that shells are found in them. The specimens of the supposed basaltes with shells included in them, that are chiefly relied on, are found at Portrush, in Ireland. I went to see these specimens in company with Lord Webb Seymour and Sir James Hall; and on examining them carefully we were all of opinion, that the stones which contained the shells, or the impressions of the shells, were no part of the real basaltes. They were all very compact, and had all more or less of a siliceous appearance, such as that of chert; they had nothing of a sparry or crystallized structure; their fracture was conchoidal, and but slightly uneven. A specimen which accompanied them, but in which there was no shell, served very exactly to explain the relation between these stones and the true basaltes. Part of this specimen was a true basalt and the rest a sort of hornstone, exactly the same with that in which the shells were, and not unlike the jasper that is under the whinstone of Salisbury Crag, and in contact with it; so that on the whole it was evident, that the rock containing the shells is the schistus or stratified stone, which serves as the base of the basaltes, and which has acquired a high degree of induration in the vicinity of the great ignited mass of whinstone. This solution of the difficulty has since been confirmed by observations made on the spot by Dr. Hope, who discovered two or three alternations of the basaltic rock, with the beds of schistus in which the shells are contained."

Simple, however, and rational as this explanation now appears, it did not convince Dr. Richardson, who appeals again to Portrush, in his opposing paper, " On the Volcanic Theory," read December 10, 1804, and published Trans. R.I.A. 1806, page 95: " a variety of basalt, found in abundance at Portrush and the Skerrie Islands, is full of pectinites, of belemnites, and above all, of cornua ammonis; these are dispersed through the whole mass, equally abundant in the interior and on the surface: this basalt vitrifies, and the marine substances it contains, calcine in the fire of a common salt-pan, of course never could have sustained a volcanic heat." And again in his Letters to the Rev. T. Dubourdieu, published as an appendix to that author's Survey of Antrim, 1812: " the pectinites, belemnites, and echinites, in the limestone strata, prove that they were formed at the bottom of the sea; we pronounce the same judgment on the fine basalt at Portrush, from the profusion of impressions of cornua ammonis scattered through these strata; and though the columnar, and prismatic basalt, over the face of the country, do not bear such unequivocal marks of their former fluid state, yet their regular forms, and the uniform thinness of their strata, could only have been acquired from a state of fluidity which necessarily induces horizontal positions."

Such were the reasonings founded upon an important fact which then remained isolated, or without apparent connexion with the general phenomena of the district. The observations, however, of the Rev. W. Conybeare, and of the Rev. W. Buckland, in their tour during the Summer of 1813, and published in the Trans. Geological Society, 1816, strengthened the opinion of Playfair, by showing that these indurated strata were, at least by their organic contents, related to the strata of the adjacent country; page 166, " about half-way, between Ballycastle and Bushmills, near Ballintoy, the chalk formation rises sufficiently high to disclose its sub-strata; a valley opening towards the sea, near White Park, shows that they here consist of the slate clay of the lias formation, with gryphites and ammonites. Farther west, the chalk cliffs again emerge from the level of the sea immediately beyond Dunluce Castle, and continue to rise till they are broken off at the commencement of Portrush strand. As they here exhibit nearly the same thickness which they possess near White Park, we are naturally led to expect the recurrence of similar sub-strata near this point, and accordingly, in the peninsula of Portrush, a singular rock is seen divided by interposed masses of greenstone, but containing ammonites and gryphites, and possessing exactly that character which would be assumed by the slate clay before described, if indurated by the action of heat." Page 213, "the peninsula itself, which may be about a mile in circumference, is fenced with low cliffs on the west, north, and east; those on the west present a rudely prismatic greenstone, those on the north and east tabular masses of greenstone, overlying, and in some places appearing to alternate with, a very remarkable rock, which has been the subject of much discussion among the supporters of opposite theories. It is a flinty slate, exactly similar to the indurated slate clay which forms the wall of the Carrick Mawr dyke, in the Ballycastle collieries: and the analogy is rendered the more striking, from the further resemblance of the greenstone of these cliffs. In this flinty slate are contained numerous impressions of cornua ammonis invested with pyrites, the shells being similar to those found in the slate underlying the chalk near Ballintoy:" and "we felt convinced while examining the spot, that the rock was no other than the slate clay of the lias formation in an indurated state."

As Sampson does not mention this rock, its history may be completed by an abstract of the paper read by James Bryce, Jun., M.A., F.G.S., &c. of Belfast, to the Geological Society of Dublin, December 10, 1834, and published in the first volume of its Journal, entitled, "An account of the celebrated Portrush Rock." In the historical part of his account Mr. Bryce adds an interesting fact, on the authority of Dr. M'Donnell, of Belfast, that "Mr. Playfair, some years after the publication of his Illustrations, visited Portrush, and in a letter to that venerable and highly-respected gentleman, expresses his entire conviction of the accuracy of his original conjecture;" but the principal features in Mr. Bryce's paper are a more close and accurate investigation of the relative positions, with respect to each other, of the igneous and metamorphosed rocks, and a more detailed statement of the extent and appearances of the latter.

Preceding writers had noticed the fossiliferous rock only on the north-eastern side of the peninsula, and hence, on comparing its low position with that of the igneous rock in the N.W., were induced to conclude that the latter overlaid the former; Mr. Bryce, on the contrary, traced the indurated fossiliferous shales to the upper portion of the S.W. cliff above the quarry facing the harbour, where they rest as in other parts of the peninsula, and in the Skerries, on the large-grained pseudo-greenstone, which constitutes the underlying rock; "it was the examination of this spot," says Mr. Bryce, "in the summer of 1832, for it is of that period I speak, (subsequent operations may have considerably altered the appearances) that first convinced me that the greenstone was the inferior instead of the superior rock, as has been generally stated, an investigation of the peninsula, with this new light thrown upon the subject, showed that wherever the two rocks occur together, this same relative position is maintained. The average thickness of the Portrush rock over the peninsula is from four to five feet." This rectification of the error of supposing the greenstone to overlie the altered shales is important; it seems to have originated in Mr. Conybeare's remarks already quoted. Mr. Bryce further states, that the strata of the Portrush rocks conform to the inclination of the surface on which it is placed, dipping N. of E. on the peninsula, and S. of E. on the Skerries; and that it frequently alternates with the trap, or greenstone, as stated by preceding writers.

The usual position of the basaltes of Ireland in respect to the secondary strata, is that of an overlying rock: it is seen, for instance, capping the chalk and its underlying strata, including the lias, in Magilligan; and it caps also the inland chalk, which in geological position is evidently above the indurated lias at Portrush; the presence therefore of an underlying mass is the more interesting as being unusual, and led Mr. Bryce to doubt the accuracy of referring the shales to the lias. Supposing the chalk to dip downwards towards the sea, Mr. Bryce imagined, from its disappearance at Portrush strand and its reappearance at Magilligan, that it might possibly dip under the greenstone and indurated shales, which in that case must have occupied a much more elevated geological position than the lias. He, however, admitted his objections to be insufficient to overthrow the received opinion, and that it was "possible that the underlying greenstone may be a huge sheet spread out under or between the beds of lias, the chalk being entirely broken off."

This paper was reviewed by Mr. Griffith, in his Presidential Address of February, 1835, in which he pointed out that the chalk, though subjected to several apparent interruptions of its continuity, dips from the sea or inwards to the land, that it is seen on higher ground westward of its terminating point on the strand, and that there is reason to believe that the bottom of the channel, between the main land and the Skerries, is formed of a lias clay. These remarks of Mr. Griffith, induced Mr. Bryce, in a postscript to his paper, to admit fully the lias origin of the indurated strata, which, however, had been fully established by the previous statement of Messrs. Conybeare and Buckland, that the fossils of the Portrush rock and of the lias of Ballintoy, are identical. The remarks of Mr. Griffith on this paper, in his Presidential Address of February, 1835, closes the history of the Portrush rock up to the present period. By pointing out that the flint slate, or indurated rock, dips at the Skerries to the south or towards the land, and connecting this circumstance with the fact noticed by preceding writers, and confirmed by himself, that the chalk on the north end of the basin dips also to the south; by showing that the chalk extends more to the west than had been supposed, "a small quarry having been opened in the interior of the country, one mile to the south of Portrush, and considerably to the westward of the White Rocks;" and by bringing forward the evidence of the pilots to prove that the channel bottom between the islands and the main land, "is composed of stiff, blackish blue clay, much resembling the decomposed lias shale at Ballintoy," he was enabled to remove the objections of Mr. Bryce, to confirm the accuracy of fossil evidence, and to conclude with Playfair, Conybeare, and Buckland, that "the flint slate of Portrush and Skerries is lias shale, indurated by the action of trap in a state of fusion," or in other words, by "an intruded mass of fused matter, which on cooling crystallized in the form of syenitic greenstone."

Mr. Griffith next points out the great differences both in mineral character and position, between the highly crystalline syenitic greenstone of Portrush and Skerries, and the tabular overlying mass of the county of Antrim, and infers that "there is reasonable grounds for supposing it either to be of prior origin to the trap of the mainland, or that it is a projection from some great dyke, which has intruded itself into the lias strata :" and on this principle, Mr. Griffith colours it differently from basalt, and associates it with greenstone, which is an original mode of viewing the subject. He notices also what even appears to have escaped Mr. Bryce, that the "greenstone changes materially when in contact with the flint slate, and from very coarse-grained crystalline, becomes comparatively fine-grained and compact, and in some places almost assumes the appearance of a homogeneous rock."

This third variety of rock, which can also be observed, and even with more advantage on the Skerries, is still most probably metamorphic, or the shale, after it has undergone that further change which induces an alteration of structure, by renewed molecular attractions and crystallization. On the whole it may be said, that these two papers leave little defect in the history of this remarkable rock.

1812.—Resuming the consideration of Dr. Richardson's Letters to the Rev. J. Dubourdieu, the next subject of interest is embodied in his remarks on the beds of ochre. These, as already hinted, are important in indicating the limits of the successive flows of basalt ; the decomposition of the surface of the underlying body of basalt to form ochre, and the subsequent induration of the ochre by an overlying bed. Dr. Richardson's observations were made with care, and are of value whether this theory be correct or not ; they were not intended to support it, as he was an advocate of the Neptunian or aqueous deposition theory, but to prove that the ochres are modifications of basalt, that both ochres and basalt were aqueous depositions, and that fire was not concerned in their consolidation. He thus sums up the result of his facts, or observations : "that the mighty ochreous strata, displayed so magnificently in most of the precipices on the northern coast of Antrim, were once pure basalt, appears clearly, as I think, from the following facts : first, we find this ochreous substance in its natural situation, in every intermediate state, between sound blue basalt, and ochre red as minium ; and we see, that the passage from one extreme to the other is by shades perfectly insensible ; secondly, we find that our ochres and basalts contain occasionally the same extraneous matters, to wit, zeolites and calcedonies, and no other, and that the mode in which these matters are dispersed through both, is precisely the same; thirdly, that the natural arrangement of basalt and the varieties of ochre, is with us the same, that is, extensive strata of uniform thickness, and steady parallelism, mixing and alternating with each other. Another question arises upon this topic: are the strata, in which we find intermediate stages between basalt and ochre, gradually proceeding to a more ochreous state? or has the cause which produced the change ceased to act, leaving these strata to continue for ever in the state we now find them? Many of the strata at Cave-Hill are in this intermediate state, as appears by their different shades of liver-colour, which has occasioned them to be mistaken for porphyry; but I do not recollect any there completely ochreous. At Bengor-Head the state of the strata is more decided, nothing but sound basalt, perfect ochre, while in the façade extending from the Giant's Causeway to Portrush, and Portstewart, we find every variety, sound basalt, liver-coloured, and pure ochre; the strata of the last description are in this course very thin. In general, the strata composed of neat pillars, rarely, if ever, become ochreous or contain zeolite."—(Stat. Surv. of Antrim, Appendix, page 13.)

Such is the account given by Dr. Richardson, of the general circumstances of the basaltic formation, of which it exhibits a clear and accurate conception. The deduction to be drawn from them he left imperfect, and expressed his apprehension that naturalists would find great difficulty in solving the several questions they involved, "human life being too short for the necessary observations." But notwithstanding this difficulty, it must have been evident to the advocates both of aqueous deposition and of igneous eruption, that alternations of hard basalt and soft ochre—of the unchanged and of the decomposed rock—that repetitions in successive beds of the same passages or transitions from the one to the other, and finally, the frequent induration of the ochre which then becomes a substance like jasper, point, as has been already observed, to successive depositions on the aqueous theory, or to successive eruptions on the igneous: and such was the conclusion arrived at by Mr. Abraham Mills, in his paper "On the Strata and Volcanic Appearances in the North of Ireland, and Western Islands of Scotland." (Phil. Trans. Vol. 80, 1790,)—as quoted by Mr. Richardson, "that the red ochre joints between the beds of rude lava, and the different heights at which the basalt pillars are seen, give probability to the conjecture that the whole mass has been the produce of several successive eruptions."

In his second letter, Dr. Richardson traces out the extent of the white limestone or chalk basin, which supports the great mass of basalt, adding an interesting fact, that far within the external boundary of the basin, there appears amidst the basalt "a small eruption of white limestone near Templepatrick;" and, on the authority of Earl O'Neil, "a similar eruption near Broughshane:" he also notices the circumstance referred to in the preceding commentary on Mr. Bryce's paper, that "the calcareous stratum, like the mass of basalt strata incumbent on it, everywhere at the periphery, dips to the interior."

1814.—"Memoir, explanatory of the Chart and Survey of the County of Londonderry, by the Rev. George Vaughan Sampson, A.B., M.R.I.A.," &c. Mr. Sampson divides the county of Derry into two districts, nearly equal but totally distinct, of which the river Roe is the boundary: "the territory of primitive rocks lying to the west, and with few exceptions the strata to the east of that river being secondary." In the most important and extended of the primitive rocks (mica schist), the author recognises several varieties: such as laminated schist or flag, lamellated schist or slate, and notices the occurrence of gneiss, and its passage into a rock which so much resembled granite," in its grain and composition as to be termed, with seeming propriety, a compressed granite." The limestone associated with the mica schist, is described as varying in character, being sometimes micaceous, sometimes highly crystalline, sometimes impure from mixture with silica and alumina. The porphyry and granite of Sliebh Gallion are noticed: and whilst the author draws attention to the "granite emerging from beneath a stratification of the usual argillaceous red sandstone," he appears to have in part perceived the true character of the porphyry, "seeming to be," he observes, "as well as gneiss, one of the boundaries from which we find, on one hand, a mutation into granite, and on the other a transition into schistus." In his Statistical Survey of Derry (1802), Mr. Sampson also notices the apparent passage of the flag, "by gradations almost imperceptible," into granite; but he does not there mention the porphyry, which, as stated in the introductory chapter, forms a link in the passage from the argillaceous sandstone into the granite.

The secondary rocks are described in succession, from below upwards, beginning with the sandstone, marley shale "included in its strata," and a "few seams of blind coal and of bituminated shale." In the Statistical Survey, Mr. Sampson mentions the trials made for coal by Lord Bristol at Tyr Crevin-burn in Magilligan, and at Ballycarton in Aghanloo: the seam then pierced, he considered a continuation of "the veins of cra-coal, mentioned as appearing in the stream of the Lynn;" and he points out Fahan-vale, Granteel, vicinity of Dungiven, and (in the memoir on the chart,) Ballynascreen, as localities where "coal might be looked for with more success, than in a seam so near to the basalt." These remarks, though somewhat indefinite in their character, are sufficient to show that Mr. Sampson considered a portion at least of the sandstones to be connected with the carboniferous epoch. Of the secondary limestones several varieties are enumerated: "lowest in stratification," says Mr. Sampson, "is the testaceous variety which, according to my present view of this matter, extends from the valley of Desertmartin to the flats of Lough Neagh, and is the same which being intermixed with sandstone, constitutes those extensive couches, passing through parts of the counties of Tyrone and Armagh, to the bases of the primitive mountains, which bound these level countries. In some districts it abounds in madrepores, in others is testaceous, containing anomiæ, gryphites, &c.;" "the lowest strata of secondary limestone frequently assume a flag-like appearance, and are composed of an hard and heavy mass of agglutinated shells, abounding in the cornua-ammonis in high preservation, their strata are accompanied by beds of marl and bituminous shale."

Though in this statement there is some confusion as to the fossils and formations, it gives a tolerable description of the mountain limestone, its shales and sandstones. "Above this, Mr. Sampson enumerates a red clay sandstone of some hundreds of feet, "lias, or magnesian limestone," which, however, is further confounded with mulatoe, a stratum of marl, and above that the white limestone." "The most singular characteristic of this surmounting couch of limestone is the beautiful arrangement of these nodules of flint, which seem to have retreated out of the vast amalgam of shell-limestone, and to have arranged themselves in rectilinear and equidistant alignments parallel always to the stratal line of this vast and magnificent series." In these passages, notwithstanding some confusion between the lias, the magnesian limestone, and the mulatoe, there is at least a recognition of a sandstone below the lower limestone, a red clay sandstone between that lower limestone and the lias, the lias, and the chalk. The error of the earlier work (Statistical Survey, 1802), in supposing that the blue limestone of Dungiven and the adjacent mountains might be the same as that of Desertmartin, dipping under the basalt on the one side and bassetting out at the other (as at Desertmartin), is omitted in the work of 1814, and would not be here referred to were it not possible that the same mistake of considering the Desertmartin limestone to dip towards the Ballynascreen Mountains, and not (as is the case) away from them, has at other times led to a misconception of the true position of the sandstones of Ballynascreen and Maghera parishes. The preceding extracts relate to general views, but the Itinerary, 1802, of an ascent of the Lyn-burn to the Waterfall at Stradreagh, is one of detail, and deserves to be recorded, as the first notice of one of the most interesting fossil localities of the country :—

"From the Bridge of Dirtagh (on the Coleraine road) to the grazing park of Lisnagruib, is an ascent of about 100 feet perpendicular. Of this the entire is of red argillaceous grit, with cross veins of matter, in grain and consistence nearly similar, except that the colour is of a bluish grey.

"At the commencement of the park, the channel of the Lyn is a deep ravine, the succession of strata are exhibited in the following order :—

	Feet.
1st. After the commencement of the Park, red soft grit	20
2nd. Greenish blue grit, sometimes effervesces	1
3rd. Black slate with dark argillaceous matter exhibiting impressions of much shells, the whole mass bituminous, including a species of inflammable cra-coal; when dry, an efflorescence appears on the surface of the section, probably sulphate of alumina	7
4th. Bluish clay, inclined to marle	5
5th. White lime, resting on a green marle-like substance, which does not effervesce	6
6th. Ochreous trap, softer as it is in contact with the limestone, occasionally resting on nodules of flint, one of which contains shells; the mass is confused basalt, shapeless, tabular, and semicolumnar, over which is the Waterfall	50

It is remarkable that this passage should not have attracted the attention of subsequent inquirers. The existence of lias in Magilligan was recognised, but the other curious facts connected with Lisnagrib were overlooked. In 1826 Lieutenant, now Captain Lancy, discovered in a neighbouring locality a marly grit abounding in a small bivalve, very difficult of identification from the rough state of the matrix; this calcareous grit becomes occasionally so hard as to be used for sharpening scythes, and then resembles Stonesfield slate ; on weathering, it exhibits numerous turrited shells, and graduating upwards, distinct lias fossils begin to appear, such as gryphæa incurva, unio Listeri, plagiostoma gigantea, &c., but the Ordnance Survey inquiries of 1838 added a new interest to the locality, by the discovery of scales and teeth of three species of fishes—saurichthys apicalis, acrodus minimus, gyrolepis Alberti—fossils which have also been identified by M. Agassiz in a very similar bed connected with the Bristol bone bed, and which, he considers from this fossil analogy, the representative of the muschelkalk of the Continent. As this subject will be again referred to in a future chapter, it is only necessary to add, that the black slates (or shales) of Sampson, which have led to this notice of Lisnagrib, contain also their peculiar fossils, namely, the cardium striatulum, &c., by which the bed is again recognised at Colin's Glen, near Belfast, distant more than 40 miles.

It is unnecessary to follow Mr. Sampson in his description of the basalt, of which he speaks as in part "a confused mixture of rude and shapeless basalt, with veins of red ochre and steatite;" and in part as exhibiting "strata of ochre, trap, steatites, and basaltes, alternated with regularity," the principal sections he gives showing the ochre in their alternating beds, and therefore corresponding to what has been before stated. In the description of soils and surfaces there are some interesting remarks as to the detritus: such as the apparent action of meeting streams, the approach to a uniform altitude above the sea of the principal detritic deposits ; and their arrangements in reference to the still existing water courses, though at considerable elevations above them, and the alternations of sand and gravel they exhibit ; but these matters will be considered in the chapter on detritus. Mr. Sampson does not mention the tertiary fossiliferous clays, of the little rivers near Muff ; it appears, however, from the information of his son, the present agent of the Fishmongers' Company, that shortly before his death he had noticed them as useful for manure.

Before closing this commentary on the two works of Mr. Sampson, which contain much valuable information, and are praiseworthy, as efforts to combine with topography, natural history and agricultural surveys, it may be remarked that, in the work of 1802, he directs, by a diagram, his reader's attention to the difficulties of determining the true dip of strata, and the chance of confounding it with the planes of cleavage, called by him, "the reclined split, or lamellar crystallization of the stratified mass." This memoir was accompanied by a Map, on which the several varieties of rocks are expressed by signs, and their relations elucidated by sections.

1816.—On the Geological Features of the North-Eastern Counties of Ireland, by J. F. Berger, M.D., M.G.S., read 1814; with an Introduction and Remarks, by the Rev. W. Conybeare, M.G.S., read 1816. The inquiries on which this paper was based extended over the Counties of Down, Armagh, part of Louth, Antrim, Derry, and part of Tyrone. It commences by pointing out the differences between the mountain range of Down, or the Mourne Mountains, and that of Londonderry; the first, consisting of a granitic nucleus, with its accompanying hornblende and greenstone rocks, is succeeded by ancient schists, greywacke, and greywacke slate, mica slate being nearly deficient, and in this respect corresponds to the southern portion of Scotland; the strata (greywacke of old times,) of the peninsula of Ardes, in Ireland, being continued in the neighbourhood of Portpatrick, and the hills of the Mull of Galloway, whilst the granite of Cairnsmuir and Criffle, enveloped by transition rocks, corresponds to that of the Mourne Mountains; "the rare occurrence or total absence of mica slate" being equally remarkable. To this may be added the further Irish extension of the same connected phenomena, in the granite nucleus, and enveloping transition strata of the County Cavan, first made known by the Ordnance Survey in 1835.

The second, or Londonderry chain, is strikingly distinguished from that of Down by a total want of the transition rocks which there prevail, and by an abundant exhibition of mica schist in all ts varieties, which is there nearly wanting. Here, too, the Irish strata are only a portion of a great deposit, rising in Derry to a considerable elevation, as in Sawel, the altitude of which is 2239 feet, broken or worn down for a space, and covered with more recent strata, in the eastern part of that county, reappearing in Antrim, and again continued in Scotland by the Cantire Hills and Grampians;—and further, there is a combination of massive and stratified rocks in this system, at least in its Irish portion, similar to that of the Down system as exhibited in its granite and greywacke. This has been noticed by Mr. Griffith, in his description (Geol. Soc. Trans. 1840) of the syenitic veins which traverse the mica schist of Antrim. In Derry, an exactly similar syenite appears involved in the mica schist of the parish of Clondermot, and though of very small extent, it exhibits more of the character of an intruded mass than of a vein. The syenite of Slieve Gallion is of a mixed character, and belongs in part to another system.

The third link of connexion between the geological structure of Scotland and Ireland, pointed out by Mr. Conybeare, is found in the overlying or erupted rocks: "the basaltic group of Ireland corresponding in constitution and position with that of the Campsie Hills, Ochills," &c. Nor are these comparisons interesting only as geological speculations; they are valuable as guides to practical research, the known facts of Scotland and of Ireland mutually illustrating each other. It will, for example, be seen further on, that pursuing these analogies new features of correspondence have been discovered in the strata of Derry and Tyrone with those of Scotland; and in like manner it may be reasonably expected that the facts ascertained and described in Ireland, may lead to new researches and discoveries in Scottish geology.

In the works of preceding authors, the extent and limits of particular formations had been marked out with accuracy; such for example as the mica schist, and the white limestone or chalk; but little had been effected in the way of a clear and satisfactory exhibition of the order of succession of all the strata. This desideratum, as might have been expected, is to a certain degree supplied by the conjoint work of Dr. Berger, Mr. Conybeare, and Dr. Buckland. The detailed description of the geology is commenced by Dr. Berger from below upwards, the "primitive rocks" being first noticed. The granite of the Mourne

Mountains is described as micaceous, and either porphyritic or finely granular; as differing in character from that of Wicklow, and appearing to correspond with "the newer granite of the Wernerians, a rock supposed to be closely allied to syenite. If," adds Dr. Berger, "the granitic formation, above described, be identified with the newer granite of the Wernerians, it may be conjectured that it reposes on mica slate:" to prove whether such be the case or not there does not exist any present evidence, but the fact that it occurs in connexion with a newer rock, through so great a topographical range, is sufficient to render its newer origin at least probable.

Syenite is stated to occur in considerable quantity at and near Newry, and to form a part of several mountain masses in Down and in Derry. "Slieve Gallion exhibits syenite in connexion with porphyry, and either of a porphyritic texture or in large concretions; I met with an elegant variety on the road from Lissan to Lough Finca: the felspar is either slightly green or flesh red, with hornblende, quartz, and some pyrites. This rock acts strongly on the magnet. In the bed of the Blackwater, near the valley of the Moyowla, on the north-west side of Slieve Gallion, the syenite is mostly composed of crystallized hornblende, with some felspar and iron pyrites, verging therefore into greenstone."

In this statement of the system of Slieve Gallion the several varieties of hornblende rocks, resulting in part from metamorphic modifications of different substances, are not sufficiently distinguished; but at the same time the view taken of the mutual connexion of the syenite and porphyry is correct and important. This is again noticed under the head porphyry, where it is expressly said, "the fundamental rock on the east side of Slieve Gallion is a variety of felspar-porphyry, strongly resembling syenite, with which rock it probably alternates in this mountain. In the same neighbourhood, felspar-porphyry may be traced without interruption, from the top of the Glen of Latterane to the bed of the Knockadoo river, on the road from Lissan to Moneymore." Alternation does not appear to represent correctly the form of connexion, or relation of these rocks, which appear, as already suggested in the preliminary chapter, to exhibit different degrees of metamorphic modification.

Gneiss, Mica Schist, Hornblende, and Greenstone Slates, Primitive Limestone.—The mica schist system, of which these are members, is noticed as occurring in Armagh: "the sides of that narrow valley which separates Slieve Gallion from the Slieve Girkin Mountains, and contains the small lake of Cum Lough, are principally composed of mica slate," a locality, however, not coloured as mica schist in Mr. Griffith's map, in the north-east of Antrim, and in Derry, and Tyrone. The river Roe is assigned as the general line of demarcation (in Derry,) between the primitive group and the secondary strata, though mica slate is occasionally seen on both sides of its channel, as at the Dog's Leay, and the Deer Park of Mr. M'Causland, and again, as an isolated mass, "surrounded by the secondary and basaltic ridges of Benbradagh and Craignashook, forming the mountain of Coolcoscrahan." Gneiss, as a distinct rock, is stated not to occur, "although the mica slate in the south-east of Antrim sometimes assumes a character which it is not easy to distinguish from that of this rock;" the same observation may be made on the mica slate of Derry, which frequently passes into gneiss; and it may be added that some portions have a fair claim to be considered true gneiss. Passing over the greywacke of Down, and the limestones which are mentioned, in error, as connected with it, to the old red sandstone, that rock is recorded in Down, and the north-east of Antrim, but not of Derry, On this Mr. Conybeare has a note, which, although it does not correct the error of Dr. Berger, bears testimony to the great difficulty of determining the true age of the sandstones: "The arrangement of the sandstone formations in the north-east counties of Ireland, forms the most difficult problem presented by their geological relations. The sandstone of Lough Strangford, with its cap of greenstone, presents so obvious an analogy to the structure of Craignashook, at the southern extremity of the flœtz trap chain in Londonderry, that we might be almost tempted to infer the identity of the sandstone, in both instances, and, since that of Craignashook is certainly the newer variety, to question the propriety of assigning to that of Scrabo Hill the antiquity which has been claimed for it in the text." The analogy between these two localities is certainly remarkable, but, as will be seen hereafter, the adjustment must be applied to Craignashook, the sandstones of which, or the greater portion of them, belonging to a more ancient epoch than the new red sandstone.

FLŒTZ ROCKS, LIMESTONE UNDERLYING THE COAL.—This, (the mountain limestone,) is very briefly noticed in Derry, at Cookstown, and in the parishes of Desertmartin and Kilcronaghan; in Antrim, at Ballycastle. The strata of the Derry limestone are said to dip to the N. W., an error which doubtless contributed to a wrong impression of the geological position of the sandstones, as in consequence they appeared to rest on the limestone, and were assigned to the new red sandstone. The coal formations of Coal Island, and Dungannon in Tyrone, and of Ballycastle in Derry, are briefly noticed; and at page 160, "the sandstone formations," the position of which is thus stated; "these deposits of sandstone appear therefore to be in every instance of greater antiquity than the lias which they support; they seem also to be partly coeval with, and partly more recent, than the formations already described, as they are seen either alternating with or overlying the members of these formations, where they can be traced in connexion with them. They may be considered as identified partly with the coal sandstones of England, and partly with the formation here known by the name of red rock marl; the lower beds of these rocks being referable to the former class of rocks, and the higher, which contain gypsum, to the latter; to ascertain, however, the precise demarcation of these subdivisions is a task for which materials are as yet wanting. A further difficulty occurs in two instances, namely, at Cushendall Bay and at Murlock Bay, where these deposits are brought apparently into contact with the old red sandstone, without the intervention of the coal measures or their associated limestone, so that it is hardly possible to assign the points at which the old sandstone terminates, and is succeeded by these younger members of the same family;" a difficulty which is also experienced in the County of Derry; the shales and limestones of the carboniferous epoch, which attain their full developement in the County of Fermanagh, gradually thinning out as they pass round through Tyrone, until in Derry they attain their minimum and ultimately disappear, leaving the sandstones in one continuous succession.

This formation of variegated marl and sandstone of the east of Derry, is traced by Dr. Berger—" rising first from the level of the sea a little to the west of Down-hill," by Magilligan, Benevenagh, Keady, Donald's Hill, Benbradagh, Craignashook, Slieve Gallion, into Tyrone. It is characterized as variable, being at Benevenagh, Keady, and Donald's Hill, " red, slightly variegated with yellowish stripes of a rather loose texture, containing specks of mica with a calcareous cement: at Benbradagh, sandstone slate, the texture coarsely granular, colour, greenish-white, with a calcareous cement and containing spangles of mica;" but though no geological discrimination is attempted between the sandstones of this extensive range, some striking variations from the above types of structure are noticed. " About a quarter of a mile from Dungiven, at the opening of Benady Glen, a sandstone conglomerate occurs, probably connected with this formation. In Craignashook, two varieties of sandstone may be traced, the upper beds consisting of a coarse grey sandstone with a calcareous cement, while the lower strata are more distinctly slaty and micaceous, and have a yellowish colour and siliceous cement." And again under this common head are enumerated the sandstones near Cookstown, grey, white, and red, and the sandstones of Coal Island. Nothing indeed can be more illustrative of the difficulty of separating and properly allocating these sandstones than this article of Dr. Berger, as it goes no further than to point out certain mineral differences, but does not attempt to found any sub-division upon them. The only clue, indeed, by which such division could be effected—namely, the presence of organic remains, had not then been discovered; nor can it be said that such discovery or any satisfactory progress towards a right conception of the geological position of the sandstones was made, until the inquiries on which this memoir is founded had proved the existence of fossils, and thereby the position of the strata in reference to each other and in relation to the strata of other countries.

LIAS, as a formation, is described by Mr. Conybeare, from his own and Dr. Buckland's observations. It is characterized as " consisting of beds of slate clay, alternating with thin seams of argillaceous limestone; the limestone is compact but not crystalline, of a bluish colour, passing into smoke grey; the fossils which characterize it are cornua ammonis, gryphites, and the columnar joints of pentacrinus." The course of this formation, though of a very limited thickness, was traced from Colin Glen. about four miles S. W. of Belfast, where the mulatto rests on a slate clay, probably of this formation," by Larne, the Island of Magee, Glenarm to Garron Point, on the east side of Antrim; it was again noticed at Ballintoy, between Ballycastle and Bushmills, and at Portrush, and inferred to exist in the neighbourhood of Magilligan, from specimens in the cabinet of the Dublin Society. The lias therefore was described in this valuable paper not only first, but with great accuracy; and when the remarkable fossil identity of the "slate clay" of Colin Glen, and that of Lisnagrib in Derry, already noticed (page 49 of this memoir), is considered, the formation acquires a new interest as a remarkable example of a deposit so limited in thickness, preserving over a considerable space of country an identity of zoological character. Mulatto, or green sandstone, is characterized as "an arenaceous stone with a calcareous cement, of a speckled appearance (whence its name), derived from numerous disseminated spots of green earth;" and as agreeing "altogether in its character and fossils with the green sandstone which occurs in a similar geological position, underlying the chalk in England." It is traced from Colin Glen through the same range as the lias, along the eastern coast of Antrim, whilst on the western side, in Derry, it is seen "along the western escarpment of the basaltic mountains, underlying the chalk in Keady, Donald's, and Ballyness Hills;" so that the notice of its occurrence as the base of the remaining portion of chalk, running towards Lough Neagh, in Tyrone, was alone wanting to complete the history of the formation.

Chalk.—The boundary of this formation, having been fully marked out by preceding writers, it is unnecessary to go over it again here. The character, however, of the deposit deserves remark, as the usual idea formed of it from the soft, friable stone, so well known as chalk, in England, is little in accordance with the hard splintery rock, known in Ireland as "white limestone," the compact texture of which, says Dr. Berger, "has caused those who were acquainted only with the superior beds of the English chalk formation, to hesitate in admitting their identity." In the introduction, the Rev. W. Conybeare says, "this formation, which in England cannot be estimated at less than 800 feet in thickness, does not in Ireland average more than

200. It agrees exactly with the lower beds of the English chalk, as seen in the Isle of Wight and Isle of Purbeck, which are distinguished from the higher beds of the same formation by their very superior consolidation. It is impossible for any two portions of the same formation to be more entirely identified, by every external character, and by the fossils and organic remains contained in them, thanare these Irish beds, which have been frequently called white limestone, with the English chalk in the above places; there, as in England, the lowest beds are destitute of flints, which the upper contain in abundance." This description, though to a certain extent correct, might lead to a conclusion that the portion of the Irish chalk which abounds in flints, resembled more closely English chalk in its structure, than the lower portion, but such is not the case; the Irish chalk being as a whole, and not merely in part, indurated.

Trap.—It is in like manner unnecessary to go minutely over the description of the great basaltic formation which overlies the chalk. The flœtz trap (in Ulster) contains, according to Dr. Berger, the following members:—1. Tabular Basalt; 2. Columnar Basalt; 3. Greenstone; 4. Greystone; 5. Clinkstone Porphyry; 6. Bole, or Red Ochre; 7. Wacke; 8. Amygdaloidal-wacke; 9. Wood-coal. Of these it is at present only necessary to notice the connexion with each other, of the basalt and the greenstone; "it is difficult," says Dr. Berger, "to determine the precise geognostic relations of the basalt and the greenstone in this district; but since the latter here occupies an extent comparatively small, it must be considered as a formation subordinate to the former; whether, however, they form distinct beds, or pass insensibly into each other by a gradual transition, is as yet undecided." The great difference between the greenstone and basalt, naturally led to the doubt expressed here, and again more strongly by Mr. Conybeare, in his note (page 126);—"it may be even objected to the instance of Cross Hill, near Fairhead, which is cited towards the end of this introduction as an example of the occurrence of trap in Antrim under the same conditions with that of Scotland, namely, in contact with the coal measures, that the trap in this instance, and through the whole range of Fairhead, assumes a character so widely different from the compact and small-grained basalt of the neighbourhood (being highly crystalline greenstone), as almost to warrant the suspicion of its being a distinct formation, notwithstanding its close geographical proximity to the great basaltic mass." The additional reason for supposing that some difference of epoch should be assigned to the greenstone and basalt afforded by the peculiar position of each in reference to the other at Portrush, has been already noticed, and that such difference, if recognised, would materially aid in tracing out the true character and geological position of other trap rocks, both in Derry and Tyrone, cannot be doubted; it is, however, a question of considerable difficulty. Mr. Conybeare thus expresses his dissent to the separation; "I confess myself, however, to be fully persuaded that this suspicion will, on further examination, be found groundless. The rock in question closely agrees in texture with that of Slievemish, which it is quite impossible to detach from the general mass of trap." Whilst, on the contrary, as before pointed out, Mr. Griffith not only recognises a distinct epochal difference, but actually applies to the greenstone of Portrush, Fairhead, and Slievemish, a totally different colour to that of the basalt. This subject will necessarily be again resumed, and it is therefore unnecessary at this stage to do more than state the case as one for observation and discussion. To this paper is appended a brief but masterly digest by Mr. Conybeare, of his own and Dr. Buckland's notes of their tour in the summer of 1813, in reference to an "Outline of Sections of the Coasts of Antrim and Derry," presented by them to the Geological Society. In these notes the various geological phenomena already noticed are further illustrated and more minutely detailed. Syenite and felspar porphyry are enumerated as beds subordinate to the mica schist; the true position of the indurated or metamorphosed fossiliferous strata of Portrush is established by the discovery of the lias of Ballintoy; the numerous changes in the level of the chalk are pointed out, and its depressions ascribed to violent disturbance accompanied by dislocation, and the difficulties of the sandstones again alluded to. This latter point, as essential to the inquiry in Derry may be noticed; "at the foot of Lurgethan, the coast presents two low cliffs divided by a valley, which affords a passage towards the sea to a small rivulet; these cliffs are composed of red sandstone and a conglomerate containing rounded fragments of quartz, the rock being altogether similar to that which Dr. Berger has described as the old red sandstone in the neighbouring hill, on which Cushendun Church is built; since, between the cliffs and the sections visible in the precipices which occur near the summit of Lurgethan, a considerable space intervenes, through which the substrata are concealed by grassy or cultivated slopes, it is not easy to determine the geological relations existing between the sandstone in the higher region and that on the level of the sea;" and such is the difficulty also in various localities of the western margin of the great secondary basin, the same analogies existing between the sandstones of both sides of the basin as between the strata overlying them. These valuable papers may be considered the first effectual step made in Irish geology, and even up to the present time, the most complete geological papers on the North of Ireland.

1829.—At this date were commenced the published geological labours of the most eminent of Irish geologists, Mr. Richard Griffith, by "Geological and Mining Surveys of the Coal Districts of the Counties of Tyrone and Antrim;" a work, which, as stated in the introduction, was written in the year 1818, although the publication was delayed "in the expectation of procuring additional information from the result of new trials for coal, which were in contemplation in both districts. In the Antrim districts these trials have not yet been made; but numerous and valuable ones have been effected in the Tyrone district within the last four years by several mining companies, the data supplied from which, though not particularised, has been interwoven with the original report."

From the necessarily specific and detailed character of a mining survey, it cannot be expected to extend its observations much beyond the limits of the particular district it embraces. Some passages, however, may be extracted from this work which are of value as showing the opinion of Mr. Griffith on the general geology of the country; "the country (he observes) in the vicinity of this district contains rocks of all classes, from the more ancient of the primary, to the newest of the secondary, and even the most recent of the alluvial formations; the primary rocks occupy the country for miles to the westward of the coal district, and extend from Slieve Gallion Mountain, in the county of Derry, by Oritor and Kildress, to the westward of Pomeroy, in the county of Tyrone. Slieve Gallion Mountain is composed of granite, syenitic granite, syenitic greenstone, and greenstone, and the same varieties of rock, apparently graduating into each other, occupy the parishes of Lissan and Kildress. To the north of these crystalline rocks the country is composed of mica slate, alternating with micaceous quartz and schistose limestone." From these passages it appears that Mr. Griffith recognised a distinct connexion between the granite and the greenstone of the district, "as apparently graduating into each other;" and though he has here classed them with the more ancient of the primary rocks, there cannot be a doubt that he would have viewed them differently had the metamorphic theory been at that time promulgated. The porphyritic character, however, of a portion of these rocks, and their association with the sandstones, which afford a clue to their true origin and position, though pointed out by Dr. Berger, he does not notice. "In an eastern direction, the primary rocks are covered by strata of the first, or old red sandstone, which form a narrow belt, and are succeeded by strata of the first flœtz limestone;" the sandstone, therefore, which in the subsequent Map of 1839 is separated into a new division, (the yellow sandstone,) is here considered the old red sandstone.

"The limestone country extends eastward for about two miles, when it is covered by alternating beds of grey sandstone, shale, impure slaty limestone, and thin beds of coal. These strata continue to the town of Dungannon: proceeding northwards from it, they are succeeded by strata of limestone of considerable purity, and these again by alternating beds of black shale, sandstone, argillaceous ironstone, and coal, which form the true coal series. In some places these latter strata are covered by beds of soft red sandstone and red marl, which rest unconformably upon them." The strata which follow in succession to the first flœtz limestone, and extend to the summit of the coal series, or in other words, from the lower portion of the mountain limestone to the upper portion of the coal, are thus divided into two sections, each containing coal. In the first the coal is only in thin beds, and the limestone is still in considerable quantity; in the second the limestone disappears, and the coal is at its maximum. This idea is still further followed up in subsequent passages: "The strata which accompany the coal, as already mentioned, consist of two kinds; the first is composed of a succession of strata of sandstone, limestone, and shale, with thin beds of coal; and the second of black shale, sandstone, and argillaceous ironstone, with numerous and thick beds of coal: the latter may be considered as belonging to the true coal formation." And again, "strata belonging to the first or lowest coal series, occur in the county of Tyrone, to the northward of the river Blackwater. The rocks which compose it occur in thick beds, and it rarely happens that sandstone and limestone are visible in the same quarry, or even in the same neighbourhood. The most remarkable instance where both occur is at the Falls of Benburb, on the river Blackwater. At this place the sandstone beds, which are the lowest, are of a yellowish-white colour, and vary from a fine to rather a coarse grain. They contain numerous impressions of large reeds, some of which are coated with a substance resembling charcoal powder. They are succeeded by limestone at least thirty feet in thickness, similar in appearance to that which forms the upper beds of the great limestone district of Ireland. The rock is compact, close-grained, and the colour varies in different beds. Some are light, and others sombre grey; the latter frequently contains madrepores and ramose alcyonites." "An extensive district, also composed of alternations of sandstone, limestone, and shale, occupies the country between Caledon and Loughrey, in the county of Tyrone. The length of this tract from north to south is sixteen miles; the breadth rarely exceeds two miles. This sandstone and limestone district is separated from that of Benburb and Gorestown by the overlying strata of variegated red sandstone already mentioned." As, then, in the preceding passages, the lower coal is distinctly separated from the upper; so in these the position of the former coal and its accompanying grits and shales, as a portion of the mountain limestone system, is implied, all the tracts here noticed, being in the Map of 1839 coloured as mountain, or carboniferous limestone; but it may be added, that whilst the general scope of the reasoning of the work under consideration is to place the limestones, shales, and grits of this lower coal system at the very top of the mountain limestones, the colouring of the Map of 1839 places them in that division of it which Mr. Griffith calls the lower limestone. At page 33, the class of formations which constitute the greatest source of difficulty in the geology of

Ireland, "sandstones" is thus noticed: the county of Tyrone contains three distinct formations of red sandstone, namely, the first, or old red sandstone, which rests upon primary rocks at the base of Slieve Gallion Mountain; second, the red sandstone of the coal formation; and thirdly, that which rests upon it, and contains fibrous gypsum;" a statement which is certainly correct, in as much as sandstone of a reddish colour undoubtedly occurs in each of these relative positions; but it will be hereafter seen that the actual determination to which of these sections each sandstone, as it locally occurs in Derry, Tyrone and Fermanagh, should be allocated, is not so simple as might be expected; and its difficulty has induced Mr. Griffith, after several alterations, to introduce the yellow sandstone as a new division. In respect to the upper portion of the series of strata enumerated by Mr. Griffith, he states that "at Cookstown, to the northward of the coal country, the red sandstone strata are succeeded by a very peculiar species of crystalline limestone, and in the vicinity of Stewartstown, and in many other places, they are covered by conformable strata of white limestone or chalk, containing flints, which are again succeeded by a thick mass of greenstone or amygdaloid, belonging to the flœtz trap formation:" taking this passage in connexion with the preceding, it would appear that part of the Cookstown limestone was considered by Mr. Griffith to overlie the new red sandstone. He adds, "thus in the extent of about four miles, we have the primary and almost every variety of secondary strata; but the series is not yet complete, for three miles to the north-east of Dungannon we find a very remarkable alluvial formation of great extent and depth, composed of white potter's clay, white sand, and surturbrand or wood coal. This alluvial district is in many parts succeeded by turf bog, which covers the whole surface of the country between it and Lough Neagh." In this brief but interesting sketch, a glimmering appears of those divisions which have been subsequently introduced by Mr. Griffith, for example, the three red sandstones: the old red, the red of the coal, and the red above the coal; according to the positions assigned to them would not exactly coincide with the old red, the yellow sandstone, and the new red sandstone, and yet in part they appear to have been the strata subsequently so designated: the sandstone and shale strata in Tyrone, Monaghan, and Fermanagh, which in the Map presented to the British Association in 1835, were represented as coal strata, being on the Map of 1839 coloured as yellow sandstone. And in like manner, the strata of shale, sandstone, thin beds of coal and limestone, which Mr. Griffith describes in his Mining Survey of 1839, as underlying the true coal system, and distinct on the one hand from it, and on the other from the main body of carboniferous limestones, may at least be considered an indication of that more precise subdivision of the mountain limestone proposed and explained in the Report of 1828. From the publication of the "Geological and Mining Surveys," to the first presentation by Mr. Griffith to the British Association of his Geological Map of Ireland in 1835, six years elapsed. Of the condition of the Map at that time no record would exist (as it was not then published), but for the small "Index Geological Map" of the British Isles, by Professor Phillips, which appeared in 1838, and, as regarded Ireland, was founded on "Mr. Griffith's large unpublished Map (by permission); and Mr. Weaver's Charts (in Geological Transactions)." It may be considered fortunate that such record has been preserved, as it is surely interesting to trace the progress of a work which at its first appearance bore evidence to great sagacity and care, as well as to unwearied labour, and in every succeeding stage to the continued search for new materials, and to the immediate application of them towards its improvement. In such cases, alterations of theoretic designations are almost inseparable from extended researches, and are the necessary sacrifices which a candid inquirer makes to truth.

The early history of this important work is thus given by Mr. Griffith, in his Presidential Address of February, 1836, to the Geological Society of Dublin: "The Geological Map of Ireland was commenced, and a considerable progress made in the great outlines, in the year 1811, chiefly from observations made by Mr. Greenough and myself. In the year 1815, numerous additional observations having been made by myself, I prepared a more perfect Map, which was exhibited at my lectures in that year. No material changes were made in the Map from that period till the commencement of last year, when, in consequence of an engagement made by me, at the meeting of the British Association in Edinburgh, to present my Geological Map of Ireland at the meeting in Dublin, I carefully examined all my notes, made at different periods, up to that time; and having transferred them to the County Maps, I prepared from these accumulated materials the Geological Map of Ireland, which I had the pleasure to present to the Association in August last. I should observe, that with the exception of a few detached hills of quartz rock in the County of Wicklow, which have been taken from Mr. Weaver's Map (and of the granite of Cavan, taken from Lieut. Stotherd's Map), the whole of the geological lines marked on the Map of Ireland, are the result of my own observations, or those of persons acting under my direction, who traced for me the detail of several of the lines of geological boundaries. The most important of these observations were made by Mr. John Kelly in different parts of Ireland, by Mr. Samuel Nicholson in the northern part of the County of Antrim, and by Mr. Patrick Knight in Mayo." These gentlemen were in the employment and pay of Government, either in the Boundary or Valuation Departments of the Ordnance Survey, and from the nature of their acquirements and duties were peculiarly fitted to assist in such an undertaking. Mr. Kelly in particular, as a leading man in both departments, had every opportunity of applying very considerable powers of observation to advantage. Of the Map thus matured, the Irish portion of Professor Phillips' Index Map was a reduction, and for the purposes of this report it is therefore only necessary to compare that Map with the published Geological Maps of Mr. Griffith, of 1838 and 1839, and with the report which accompanied the Map of 1838, in order to have a distinct view of the progress made in the geology of the district to be here described, in the period between 1835 and 1839.

1. THE MICA SCHIST FORMATION exhibits very little variation in any of the three Maps; and the sedimentary primary rocks are described generally as consisting of mica slate, shining slate, quartz rock, and primary limestones.

2. SILURIAN.—In the small Map of Professor Phillips no silurian strata occur, the Tyrone deposit of that epoch being included in the old red sandstone. In that of 1838, attention having been drawn through the discovery by the Ordnance Survey Collectors of numerous silurian fossils in the coarse schists of Pomeroy and Desertcreat parishes, to the existence of a small district of that geological age in the County of Tyrone, the

space occupied by the fossiliferous schists is marked on the map, but left uncoloured, no colour having at that time been appropriated by Mr. Griffith to the silurian strata.

3. SANDSTONES.—Taking the whole series together from the old red to the new red sandstone; in the Map of 1835 the old red bordering the syenitic rocks of Tyrone and the mica schist of Tyrone and Donegal, extends in one great mass from the S.E. corner of Derry to Lough Erne in Fermanagh; broken at its north-western corner by some intercalated patches of mountain limestone, and bounded on the eastern and southern faces by mountain limestone, and on the western face by the limestone and by Lough Erne. A large patch appears to the north of the greater one, in the County of Tyrone, lying in a north and south direction between Newtown Stewart and Strabane, its longer axis being east and west; a lesser, surrounded by the mountain limestone, west of Lough Erne, and between it and Lough Melvin; and a narrow strip extends from the N.W. corner of Lough Erne, passing north of Lough Melvin, along the sea-shore to Gessigo Point in the County of Sligo. A very small patch occurs, surrounded by limestone, south of Dungannon. It is unnecessary to proceed further topographically, in reference to these or other strata, in the present report, but it may be observed generally, that the old red is represented as the only rock between the older, primary or transition, strata, and the mountain limestone. Of sandstones of the coal, with shales, &c., which it is presumed include the second red sandstone before mentioned by Mr. Griffith, a considerable patch, its longer axis lying E. and W., appears south of Fermanagh, and is that subsequently stated by Mr. Griffith to extend from Emyvale, in the County of Monaghan, to Brookborough in Fermanagh, a part separated from the greater mass forming a small isolated patch at Emyvale, and between Aughnacloy and Caledon: the very small patches in the Leitrim district, surrounded by the millstone grit, are beyond the limits of the present report. In the third division, or new red sandstone, are included all the sandstones of the County of Derry, the new red separating the mica schist of that county from the newer secondary strata and overlying basalt; the chalk in the small Map of Professor Phillips, is, however, from the smallness of the scale, imperceptible

on the western escarpment. In the east of Tyrone and north of Armagh it borders the mountain limestone; in the N.W. of Down the greywacke; and in the S.E. and N.E. of Antrim it again appears as underlying the chalk, &c. Such, then, was the distribution of the sandstones, and their relative geological positions in the Map of 1835. Subsequent, however, to the meeting of the Association in that year, Mr. Griffith visited Ulster, in company with Professor Sedgwick, Mr. Murchison, and Professor Phillips, three of the most distinguished of modern geologists, and from their opinions and his own observations, was induced to doubt the accuracy of the new red sandstone district, and to modify it as well as some others considerably. Previous, therefore, to the publication of the Map of 1838, he adopted a new subdivision, under the name of "yellow sandstone," which is so far an unfortunate designation as it tends to perpetuate a defective system of nomenclature dependent on colour, at a time when other geologists, having discovered that colour and structure considered at one time characteristic of particular strata are common to many, were seeking to replace such designations by others less liable to misconception, such for example as "Devonian," for old red. Nor is there indeed, any peculiar yellow tint to justify the name: the sandstone so coloured exhibiting every gradation from white and grey to red. In the table of colours appended to the Map of 1838, the "yellow sandstone," is placed next above the old red sandstone, and immediately below the "carboniferous, or mountain limestone," and in the report which accompanied the Map is described as at the base of and in the lowest section of the carboniferous limestone.

1st. Yellow sandstone, limestone, and shale.

2nd. Lower limestone.

3rd. Impure argillaceous limestone called calp, black shale, and sandstone.

4th. Upper limestone.

It is thus described; "yellow sandstone," the lowest member of the series, usually consists of quartzy sandstone conglomerate, which varies from coarse to fine-grained, and passes into sandstone. In some instances, though rarely, this conglomerate contains rolled masses of carboniferous limestone; it is usually followed by a succession of strata, consisting of yellowish-grey, or yellowish-white sandstone, which, when fully developed, amounts to a considerable thickness, and occasionally forms hills of moderate elevation. The yellow sandstone strata are sometimes free from the intervention of any other rock, but frequently its beds are interstratified with dark grey shale and with dark grey limestone, more or less pure. In some localities very thin beds of impure coal occur, interstratified with the sandstone and shale; a circumstance which has unfortunately led to many expensive but fruitless trials for coal in different parts of Ireland; and one (at Latt, one mile north of the town of Cavan,) is at this moment in progress. The average thickness of this system may be about 600 feet, though in some instances its strata exceed 1000 feet in thickness. The yellow sandstone beds usually succeed the old red sandstone, and where it is wanting (which frequently happens,) they rest upon the primary or transition rocks. Hitherto the lower conglomerate and sandstone members of this series have been considered to belong to the old red sandstone; but as in several localities these strata are found to alternate with beds of limestone, containing the fossil organic remains of the carboniferous limestone, it becomes evident that they form a portion of that series."—(Appendix to the Second Report from the Railway Commissioners, Ireland, page 9.)

The language of the report, and the place assigned to the yellow sandstone in the table of colours together, show that though associated with the limestone strata in the report, this formation was considered to be in part taken from the old red sandstone, and as distinctly underlying the "lower limestone," which in the preceding report of Mr. Griffith, was the base of the mountain limestone system. On this view, alterations of colour would be expected along the edge of the old red sandstone, and several such alterations occur in the Map of 1838. The isolated patch between Newtown Stewart and Strabane is entirely changed from old red to yellow sandstone; of the great mass of old red extending nearly from Cookstown in Tyrone to Lough Erne, a small patch on the north-east corner is separated as yellow sandstone, as well as a considerable strip on the north-west corner, whilst a smaller patch is coloured as millstone grit. The portion on the opposite side of Lough Erne, and the strip extending to Gessigo Point, are in like manner changed to yellow sandstone. The narrow strip of old red sandstone which extended from Monaghan toward Cavan, is almost entirely omitted, and merged in the mountain limestone. The large and small patches lying between Emyvale and Brookborough are changed from "the coal strata" to the yellow sandstone, and with the exception of a small strip bordering the chalk and basalt, the whole of the sandstones of Derry are changed from the new red sandstone to the yellow sandstone, so that it would appear that sandstones supposed in the Map of 1835 to belong to three distinct epochs widely separated from each other, the old red sandstone, the coal formation, and the new red sandstone, were in that of 1838 all reduced to one formation, the "yellow sandstone;" a change which may be received as evidence of the extreme obscurity of the geological structure of the country. In respect to the alteration of the colour of the coal strata, there appears to be a contradiction between the Map of 1838 and the report accompanying it, as the latter represents these strata as belonging to the calp or black shale series, (between the upper and lower limestone,) and not to the yellow sandstone; "it would be tedious, and almost endless to enter upon a particular description of the numerous localities in which the calp series occurs in the north of Ireland; at present we need only observe, that the shale district, extending from Emyvale, in the county of Monaghan, to Brookborough, in the County of Fermanagh, known by the name of Slieve Beagh Mountains, has long been considered to belong to the true coal formation" (and was so represented by Mr. Griffith in 1835), "and sanguine expectations have been entertained of the discovery of valuable beds of coal; but having ascertained, that in the order of succession it forms a portion of the calp series, it appears very improbable that these expectations will be realised;" why then a tract here stated to belong to the "calp series," which is separated from the yellow sandstone by the lower limestone, should have been coloured in the Maps of 1838 and 1839, "yellow sandstone," is not apparent. In the Map of 1839 there is no material alteration of this portion of the old red and yellow sandstones, a small strip is, however, separated from the old red, north of Ballygawley and Augher, as well as S.E. of Ballygawley, and classed with the yellow sandstone; and several isolated patches of yellow sandstone are introduced in the mountain limestone, as for example, west of Coal Island.

at Lisdhu, Castlecaulfield, Killeeshil, Carnteel, Aughnacloy, Favour Royal, and some others; whilst modifications of a similar character, though in a contrary direction, are made by the introduction of patches of limestone into or within the colour of the yellow sandstone. These facts are of importance in a consideration of the true geological age of these sandstones, as the various positions in which they occur must necessarily induce a doubt as to their union under one denomination in some cases, and their separation in others. Mr. Griffith indeed states, in respect to the insulated ridges and hills, "composed of this sandstone," which occur "in the interior of the great carboniferous limestone district, that being formed in each case by an undulation or upheaving of the strata, the sandstone beds dip on all sides towards, and pass under the surrounding limestone;" and as such ought assuredly to be the case, according to the defined position of the yellow sandstone, it will be applied as a test in examining the several detached deposits above enumerated. And further, in respect to the most "remarkable of these detached ridges," Mr. Griffith observes, "the whole of these sandstone ridges and hills have been heretofore considered to belong to the old red sandstone period, but, for the reasons already adduced, they are now considered to belong to that of the carboniferous limestone;" and hence it may be finally remarked, that no strata should be admitted into the yellow sandstone subdivision, according to the view taken of it by Mr. Griffith, excepting such as may be considered either the summit of the old red sandstone, or the base of the carboniferous limestone system.

Mountain Limestone; the germ as stated (page 62) of a subdivision of this great formation, existed in the report of Mr. Griffith of 1829; the shale, sandstone, and limestone, with their beds of coal, under, but not forming part of the true coal formation, being a subdivision of the carboniferous limestone, and in the Map of 1839 this thin strip near Dungannon, is accordingly coloured "upper limestone." In the report of 1838, the principles of division are detailed and the several subdivisions specified and described. The "yellow sandstone," or lower transition member of the system is followed by the lower limestone, which is the most highly developed of all the subdivisions; in it Mr. Griffith places the various marbles of Mayo, Galway, Kilkenny, Armagh, &c., and with the exception of the narrow tract near Dungannon, and that represented in contact with the millstone grit of Fermanagh, Cavan, &c., it is the only subdivision shown on the Map of 1839 within the range of this report. As regards its position on the three successive Maps there is no material alteration: one small addition deserves, however, to be noticed, namely, the arm projecting from the limestone of Desertmartin, along the northern face of Slieve Gallion, which being drawn as if united to that of Desertmartin, obscures the phenomena, as it has neither the direction nor dip of the Desertmartin limestone, occupies a level some hundred feet higher, and has other points of difference, there being no topographical connexion between them. Calp or black shale series; the name calp, originally given by Kirwan, to the black argillaceous limestone of the neighbourhood of Dublin, is here used as the name of a subdivision; in the Map of 1839, it occupies a considerable space along the boundary of Fermanagh and Cavan, but does not appear within the present district; the portion allotted to it in the report of 1838 having been coloured "yellow sandstone;" it is, however, most probable that these strata occur in other localities, though from the diminution of the shales they are not so easily recognisable by mineral characters.

Upper, or Splintery Limestone.—"This rock," Mr. Griffith states, "is comparatively of rare occurrence in Ireland, and its superficial extent insignificant;" in the present district Mr. Griffith notes it on Belmore Mountain, where its thickness "amounts to 650 feet; at the eastern base of Cuilcagh Mountain in the valley of Swanlinbar, in the County of Cavan, where it is 600 feet;" and as "surrounding the coal formation of the County of Tyrone, where, commencing at Dungannon, it extends towards Stewartstown, and thence underlying the small coal field of Annahone, north of Stewartstown, continues by Killymoon to Cookstown, in which neighbourhood it is covered by strata belonging to the new red sandstone;" but of this tract, only that small portion south-west of the coal district, and ranging from Dungannon to Lisdhu, is on the Map of 1839, coloured as the upper limestone. Such, then, is the view taken by Mr. Griffith, of the mountain limestone system: it is only approximative, as he observes, "it is probable, when more detailed examinations shall have been made of the fossil remains contained in each of these groups, we shall discover types leading to a more perfect classification. In the mean time we must be satisfied with one which is derived solely from the observed variation, in the mineral character or composition of the strata, as they succeed each other." In the present district much can be done towards this desirable object; but it can be done only by diligent research and much labour, as the strata do not constitute one continuous mass, and, by exhibiting great lines of successive deposits, render the tracing of formations comparatively easy, but on the contrary, assume so many varieties of form and so frequently change in direction of strike and dip, as to render it necessary to seek and recognise some leading fossiliferous member in each little detached system, to serve as a link of connexion with others.

Millstone Grit.—" Rocks, decidedly belonging to this series (Mr. Griffith's Report, 1838, page 13), are only met with in the mountain district surrounding Lough Allen, in the Counties of Roscommon, Leitrim, Cavan, and Fermanagh, hitherto known by the name of the Connaught Coal District; and in the shale district, extending from Drumquin in the County of Tyrone, to the neighbourhood of Pettigoe, in the County of Fermanagh. Both these districts contain coal, and on this account they have hitherto been considered to belong to the true coal formation; but being in many respects analogous to the millstone grit of the North of England, as described by Professor Sedgewick and Professor Phillips, and as it contains the remains of marine exuviæ, which occur from the lowest to the uppermost beds of the series, there can be no hesitation in considering it to belong to a different class from that of the true coal formations of Ireland." The formation in its full developement is described as consisting of, first, " three great beds, or successions of beds, of yellowish-white quartzy sandstone, having beds of black shale interposed between each;" the sandstone beds presenting a succession of terraces, and the shale beds forming comparatively flat swampy plains, the thickness of the whole amounting to about six hundred feet; then comes the great shale of Cuilcagh Mountain, whose aggregate thickness exceeds 700 feet; the lower beds consisting of thin alternations of black shale with impure dark bluish-grey argillaceous limestone, which contains many of the fossils common to the carboniferous limestone series."

In ascending, " the calcareous beds gradually diminish in thickness, and at length entirely disappear, the shale beds being thin," associated with numerous and frequently thick layers or beds, and " also with large flattened spheroids of argillaceous ironstone, some of which are extremely rich in iron, and were formerly worked. Many of the flattened ironstone spheroids are extremely large, and some, which are reticulated by veins of calcareous spar, present magnificent specimens of septaria." The shale with ironstone " contains a profusion of casts of marine organic remains, many of which differ from those of the subjacent limestone; and it is this circumstance which has induced the classification of the strata which immediately succeed the upper limestone, with the millstone grit series, in preference to that of the carboniferous limestone." Still ascending, " the ironstone beds become thin and at length disappear; and the upper portion, 250 feet thick, consists altogether of fine-grained black shale, containing organic remains, but particularly of posidonia, but not so abundantly as in the lower beds, which alternate either with the impure limestone or the ironstone." This great mass of shale is succeeded by an accumulation of beds of yellowish-white sandstone, about 250 feet in thickness. " In the lower portion, next the shale, the sandstone beds are thin, and alternate with sandstone slate and shale; the upper consists of thick beds of yellowish-white quartzy sandstone, some of which are rather coarse-grained, and assume the true character of millstone grit. This rock occasionally contains vegetable organic remains, particularly some varieties of stigmaria:" it forms the summit of Cuilcagh Mountain, 2188 feet above the level of the sea. Then follow in geological succession, alternations of shale and sandstone with three beds of coal, one of which, in Brahlieve Mountain, is three feet thick, though in others the same bed is less than two feet thick: " but unfortunately the extent of this coal field, which is confined to the summit of Brahlieve and Slieve Kurkagh Mountain, is so inconsiderable, that no extensive collieries or manufactories can be successfully established; consequently we cannot expect that this district will at any period produce an abundant supply of fuel for distant markets." The well known Arigna Iron Works are connected with this coal field. From this detailed description it appears that the great accumulation of shale and sandstone contains, in all its lower members, marine organic remains, principally corresponding (as far as examination had then gone), with those of the mountain limestone, and in its upper, assumes a totally different character, containing "vegetable organic remains" and considerable beds of coal. "In the millstone grit district, which extends from the neighbourhood of Drumquin, in the County of Tyrone, towards Lough Erne, in the County of Fermanagh, the series is very imperfectly developed. It also contains coal, but the beds are too thin and impure to repay the expense of working." The district was coloured in the Map of 1835, as part of the coal formation, &c., on the Map of 1838 and 1839, according to the view here taken of it by Mr. Griffith, as millstone grit; at present, it is only necessary to remark respecting it, that the determination of its true geological position is attended with some difficulties from the confined space it occupies; but taking one fact into consideration, when comparing it with the great system or systems of sandstones and shales of Cuilcagh, Brahlieve, &c., namely, that whilst the coal in the latter is connected with the upper portion of the system, in the former (the Drumquin district), it is overlaid by a considerable thickness of calcareous grits containing fossils of the mountain limestone epoch, doubts may be entertained of the identity of the two.

The principal coal formation of Tyrone has already been noted in commenting on Mr. Griffith's first report, specially directed to the subject; the Drumquin district has been changed since 1835 to millstone grit, aud the other detached districts of Tyrone, Monaghan, Fermanagh, and Cavan, to yellow sandstone; that of Carrickmacross, however, still retaining its original position. Upper members of the secondary class: the alteration made since 1835, in the new red sandstone of Derry, by changing it to yellow sandstone, has already been noticed; the lias, on the Map of 1839, does not appear west of Portrush, not being marked on the face of Benyevenagh, or in Magilligan; to these succeed the greensand, chalk, and overlying trap, on which at present it is unnecessary to dwell, as their boundary had been previously, and at an early period, marked out with tolerable accuracy. Taking into account also the magnesian limestone of Hollywood, on the south side of Belfast Lough, Mr. Griffith observes, "consequently we may be said to possess portions of the whole upper series of the secondary rocks of

England, with the exception of the oolite, though traces even of that formation have been discovered on the coast near Larne, in the County of Antrim."

Tertiary Formation.—Mr. Griffith only notices in his report as decidedly tertiary, the alluvial formation mentioned in the former report; he says, "in Ireland, the tertiary formations are less extensive than those of England, they are probably lacustrine; though as yet no animal exuviæ have been discovered to enable us to determine that point. The most important deposit belonging to this class is situated along the south-eastern margin of Lough Neagh, between Washing Bay, near Mountjoy Castle, in the County of Tyrone, and Sandy Bay, in the County of Antrim. In the County of Tyrone, and the northern part of the County of Armagh, this deposit occupies a district of ten miles in length, by five miles in breadth; it is composed of alternations of white, brown, and greenish-blue clay, with white and grey sand, and irregular beds of lignite, or wood coal, and on the margin of Lough Neagh, of silicified wood. In some localities the lignite is very abundant and particularly on the shore of Sandy Bay, on Lough Neagh, where, during seasons in which fuel is scarce, the inhabitants occasionally sink pits and raise it for domestic purposes. The clay district of Lough Neagh is similar to the potter's clay district of Bovey, in Devonshire, and pits have been opened in many parts for the purpose of raising pipe-clay and potter's clay; but hitherto no beds of a pure white colour have been discovered, at least none which preserve their white colour when exposed to the heat of the potter's baking furnace; but there can be no doubt, if proper trials were made in different parts of the district, that pure white potter's clay would be discovered. The apparently elevated gravel deposits of the County of Wexford, and other localities which contain marine shells, have not been as yet sufficiently explored to determine whether they should be classed among the tertiary formations, and consequently they have not been included in that series." The latter, or raised marine deposit, was first brought under notice by Mr. Griffith in 1835, the former, or "lacustrine" tertiary deposit, had been noticed, prior to his earliest report, by Barton, in "Lectures on the Natural History of Lough Neagh," published in 1757; and subsequently to the Coal Field Report (1829), but prior to that of 1839, by Dr.

Scouler, in a paper read to the Geological Society of Dublin (Jan. 11th, 1837). In this paper Dr. Scouler enumerated the various writers who had treated on Lough Neagh and its supposed petrifying qualities, namely, Nennius, between the seventh and ninth centuries (as quoted in Ogygia), Higden (14th century), who supposed that the portion of wood imbedded in the mud under the water became iron, the wood surrounded by water stone, and the wood above the water remained wood. Dr. Boate, 1652, Dr. Molyneux, 1684, and Mr. Smith, (his correspondent,) " who, residing in the vicinity of the Lough, had observed that many specimens of fossil wood were found at a great distance from the shores; and hence concluded that the petrifying property belonged rather to the soil than to the water;" the first approximation to a correct view of the subject. Barton (1757), living in the vicinity of the lake, was indefatigable in gaining information and collecting specimens of fossil woods; " some of his specimens were of considerable size, one of them weighing no less than 700lbs. It is also deserving of notice, that he mentions one specimen, in which the wood had been changed into iron pyrites. But by far the most important information which he communicates, is that which relates to the geological relations of the fossil woods, and their associated lignites. He states, that, at a place called Ahaness, which is nearly opposite Ram Island, and not far from Glenavy Waterfoot, the silicified wood is found in a bed of lignite which is covered by a stratum of clay; at this locality, there is a bank on the shores of the lake twelve feet high, and about ninety feet distant from the water. Under the bank the following section was obtained by digging: 'the upper stratum was a bed of red clay, three feet deep; the second, a stratum of blue clay, four feet deep; the third was a stratum of black wood, four feet in thickness, which reposes on another stratum of clay. This stratum of wood is of one uniform mass, and is capable of being cut with a spade. Sometimes the wood will not easily break; in that case, it requires the aid of some other tool to separate it from the mass; and may, if properly done, afford a block of two, three, or four hundred pounds, which being carefully examined, is found to consist more or less of stone.' To Barton, therefore, the merit is due of being the first to ascertain the relation of the silicified wood to the lignite; I must add that, in all matters of fact, I have found him a faithful and accurate guide,"—(Scouler. Journal Geol. Society of Dublin, Vol. i. page 233). Dr. Scouler then gives the result of his own observations: he divides the superficial formations, exclusive of the peat, into "two sections; the inferior one consists of beds of clay and bituminous wood or lignite; and the upper consists of transported masses of gravel, which are usually called diluvium." The inferior formation, as Mr. Griffith has observed, may be "considered analogous to the Bovey coal, or perhaps still more to the association of beds of clay, lignite, and volcanic rocks, which are found in the Basin of Neuwid on the Rhine. Mr. Griffith is the only writer who has noticed the beds of clay and lignite which occur at Verner's Bridge, on the edge of the Dungannon coal field;" and "deposits of lignite are found at different places around Lough Neagh, from Dungannon to Glenavy, forming a circuit of about twenty miles."—(Scouler, &c., page 234.) He then notices in detail the localities and circumstances of the deposit along the margin of Lough Neagh, as well as some of those still more remarkable deposits of lignite which occur under a covering or between two layers of basalt; and considers the silicified woods not "to be co-extensive with the deposits of lignite;" "no specimens having been found at Verner's Bridge, near Dungannon, in the potter's clay and lignite which are found there; neither have any specimens been yet found in the lignites under trap in any locality throughout the country. If we take a survey of the district in which the fossil wood is found, we shall find that it extends from beyond Cranfield in the north, to the parish of Segoe in Armagh, on the south (page 238). This formation of trap (referring to the columnar basalt of Shane's Castle, &c.), or perhaps, pitchstone trap, appears to be in some way related to the silicified woods, at least, the two appear to be very nearly co-extensive, and may possibly have more points of affinity than that of mere juxta-position."—(Page 239). In respect to this connexion of the basalt with the silicified woods, more evidence is necessary; and some doubts may exist as to the limits assigned to the silicified woods by Dr. Scouler, for though they have not been found in the potter's clay near Verner's Bridge, large lumps have been discovered in the superficial detritic stratum of Coal Island, which must either have proceeded from some deposit of the immediate vicinity, or have been washed over from the Antrim district, which, on account of the form of the fragments, is improbable. Returning to the works of Mr. Griffith it only remains to notice the igneous rocks. In the Map of 1835, the whole of the supposed igneous tract of Slieve Gallion, &c., was coloured syenite; in 1838, part of it was very properly separated, and coloured crystalline greenstone; and the same principle is adopted in the Map of 1839. This, in respect to the Slieve Gallion district, conveys an erroneous impression of the phenomena; some portions of the rock-coloured syenitic granite, being probably more recent than the crystallized greenstones of the same district, both indeed being metamorphic rocks, but the one metamorphosed from a newer stratum than the other. The principle of separating from the trap or basalt the "greenstone protrusions," is in part correct; "these intrusions consist of two kinds, namely, whin dykes, or basaltic veins, and huge amorphous masses of greenstone, or greenstone-porphyry, which occasionally form large mountains, and which among igneous rocks are only secondary to granite in point of extent and importance. From the striking effects which they have frequently produced upon the chalk and other rocks belonging to the more recent of the secondary class, it becomes demonstrable, that in many instances they are co-eval with, or of subsequent origin to ordinary trap dykes."—(Railway Report, App. i. page 22). Sleamish, in Antrim, is coloured as one of these protrusions, as is the greenstone rock of Portrush. The subsequent paper of Mr. Griffith, read to the Geological Society of London, on veins of syenite traversing the mica schist of Antrim is valuable, as bringing forward new examples to show that rocks partaking of the characters of granite may also have been ejected subsequently to some or many of the sedimentary strata; it is, however, necessary to use considerable caution in drawing the line between igneous rocks, and those resulting from metamorphic action. Mr. Griffith on this point remarks, that "the porphyry of Cushendal probably results from fused red sandstone;" and it has already more than once been stated that the syenite, porphyry, and greenstone of Slieve Gallion, are almost demonstrably metamorphic rocks.

It is hoped that this abstract conveys a tolerably clear view of the important geological labours of Mr. Griffith, up to the year 1839; and it will be closed by a brief notice of some portions of a paper by Mr. James Bryce, on the "Geological Structure of the north-eastern part of the County of Antrim" read to the Geological Society of London, May 2nd, 1832. Mr. Bryce describes in detail the sandstones of the two great divisions of detritic rocks, the old red and new red sandstones, and endeavours to found a recognisable distinction between them on their respective mineral structure; his paper therefore has an important bearing on the general consideration of the sandstones.

OLD RED SANDSTONE.—"This rock has little of the conglomerate structure; being most commonly a coarse-grained whitish sandstone, with a little admixture of argillaceous and calcareous matter. It contains some fragments of other rocks, but in very small proportion to the mass; the fragments are water-worn masses of resinous quartz, varying in magnitude from the smallest particle to the size of a man's head; also several varieties of porphyry, many of them the same as those of Kilnedore and the Knockans, afterwards to be described; but many of them have no resemblance to these porphyries, subordinate to the mica slate, or to any other porphyry known by me in situ, in the North of Ireland. Some of the imbedded masses are the same as the base itself, showing either that parts of the rock have been derived from pre-existing portions worn down and afterwards recomposed, or that a pre-existing rock of very similar structure has been entirely worn away in supplying materials for this great mechanical deposit. I have observed no *pebbles of granite or mica slate.* The largest of the fragments are identical with the base itself, while those of quartz are by far the most numerous. In most of the strata the fragments are few; they are rare in those adjoining the mica slate, while they occur in greater quantity and variety in those in contact with the newer conglomerate. The rock, moreover, often loses its coarse-grained gritty structure, and assumes a fine-grained sandy texture, like a grey freestone."

NEW RED SANDSTONE AND CONGLOMERATE.—According to the view taken by Mr. Bryce, this formation exhibits all gradations in fineness of material from a coarse reddish conglomerate, through sandstones coarse and fine,—red and sometimes white, until the fragments gradually diminishing in size and in quantity "they ultimately disappear, and the rock becomes a fine marl:

thus the conglomerate with its enormous imbedded masses, graduates so imperceptibly into a fine red sandstone, that it is altogether impossible to separate them in nature." This conglomerate was considered by Dr. Berger and Mr. Conybeare, to belong to the old red sandstone; but by Mr. Bryce it is classed with the new.

"It may be questioned," he observes, "whether the rock which I have called new conglomerate, should be separated from the old red sandstone. The facts surely warrant such a separation, and it may be well to recapitulate them. In our old red sandstone granite or mica slate pebbles never occur, while both are found, the latter most abundantly, in the conglomerate. The conglomerate covers the mica slate and old red sandstone unconformably. The porphyry overlies the old red sandstone, but is covered by the conglomerate: besides in Red Bay and Murlogh Bay, there is a clear gradation from the conglomerate into the new red sandstone." Within so limited a space as that embraced by this portion of the paper, the mode of comparison by differences of mineral composition is admissible, and the result is here extremely curious; the rock which is in immediate contact with the mica schist and of the two geologically nearest to it, contains no fragments of it, whilst that which is separated geologically and in general topographically from the mica slate, abounds in such fragments, as well as in those of other primary rocks. This peculiarity is opposed to the condition of these rocks in other localities, the conglomerates, for example, of the great body of the lower strata of the old red sandstone, as exhibited in Tyrone, Fermanagh, and also to a lesser extent in Derry, containing numerous fragments of primary rocks, whilst the pebbles of the upper strata of the old red, being one division of the strata altered by Mr. Griffith to yellow sandstone, are generally rolled fragments of quartz. Mr. Bryce, however, distinctly states (page 76), "here also it rests in nearly horizontal strata upon the edges of the highly-inclined beds of mica slate, and old red sandstone; and when near the mica slate its base is often very micaceous." Such super-position is decisive as to relative age, and Mr. Griffith adopts in his Map the same topographical range for these strata; but when the condition of the deposits elsewhere, above referred to, and the obscurity which envelopes them, are considered, it may be suggested that further investigation is yet required to establish beyond doubt the geological epochs of these sandstones. The porphyry, "clay-porphyry and clinkstone-porphyry," is described as intermediate in age between the old red, and new red sandstone, as it "overlies the old red sandstone, through which it has been most probably erupted and is covered by the new conglomerate." It is probable, however, that the reasonings advanced in respect to the constitution and relations of the porphyries and syenites of Slieve Gallion, are equally applicable to those of this country, the varying result of metamorphic action being the consequence of difference of composition in the rock metamorphosed. Mr. Griffith, for example, supposes that "the remarkable porphyry of Sandy Braes, belongs to the red ochre beds; "while the porphyry of Cushendal probably results from fused red sandstone;" and although the first position is doubtful, there is much reason in the proposition itself; the general idea having been before expressed by Dr. Buckland, "who observed that the cement of the conglomerate often passed from a mechanical to a chemical state, and assumed all the characters of regular clay porphyry, of a reddish colour."—(Rev. W. Conybeare, Trans. Geol. Soc. Vol. iii. p. 202). Mr. Bryce notices within the tract between Cushendun and Cushleak, which in Mr. Griffith's Map is represented syenite, "beds of felspar porphyry;" and he describes a "dyke of syenite S.E. of Murlogh Bay: the subject of syenitic dykes in that region has, however, been subsequently treated in detail by Mr. Griffith, in the fifth Vol., 2nd Series, Trans. Geol. Society. It is only further necessary to notice one passage in reference to the

Coal Formation.—"At the south-western termination of the area, near Maghera and Cairntogher, in the County of Derry, a small coal formation occurs, resting upon carboniferous limestone, and old red sandstone on the one side, and upon mica slate on the other, thus affording a complete analogy with the Ballycastle district." This passage, so far as it relates to the existence of a formation which exhibits traces of coal, is an approximative correction of the first Map of Mr. Griffith, in which the whole district is coloured "new red sandstone," but the actual super-position of these strata to the carboniferous limestone is not so evident, the dip of the limestone and the sandstones, shales, &c., being all to the eastward, whilst the topographical position of the latter is westward of the limestone. Mr. Griffith, as already stated, has since classed them with his yellow sandstone.

This analytical examination of preceding writers, though it may have appeared tedious, was necessary, in order to set the argument in a clear light, and to do justice to those who have observed and described so much. It may be seen from it, that the country to be now geologically considered, is not an unknown region, and that it is rich in geological facts, and full of difficulties.

1842.—Since the preceding remarks were written, Mr. Griffith has brought forward a second edition of his Map, in which the principal alterations as regards this portion of the North of Ireland, are—1st. The removal of the great mass of Slieve Gallion from the crystalline greenstones to the hornblendic slates or metamorphic rocks; a proper, and in respect to principle, an important change, as they cease to be associated with the crystalline rock of Portrush and of other localities. 2ndly. The introduction of the lias on the western escarpment of the chalk; but at present I am not aware that this change has been made from actual examination, as the lias is extended some miles beyond the point where our own examinations have traced it, and where according to them it would appear to cease.

NOTE.

Extracts from the Manuscript Journal of Bishop Nicolson, for the use of which I am indebted to Frederick Lindesay, Esq., his Great-grandson:—

"March 17. 1718 (St. Patrick's Day).—The King was pleas'd to nominate me to the Bishoprick of Londonderry, as was signify'd to me (in the House of Lords) by the Duke of Bolton L^{d} L^{t} of Ireland. And, the next day, His Grace introducing me, I had thereupon the honour to kiss His M$^{y's}$ hand.

"May 23rd.—I set out in y^{e} Chester Coach with Lady Margaret Davis, Mrs. Scloser, Col. Irwin, &c.

"June 1st (Whitsunday).—We landed at Ring's End, whence

" 2nd.—Fetch'd by y^{e} B^{p} of Meath, who (p. m.) carry'd me to wait on L^{d} Chanc^{r} Brodrick, B. Pocklington, &c.

"June 21st.—Going through y^{e} L^{d} Mountjoy's Woods, and by his demolish'd House at Newton-Steward, we were met by D^{r} Hamilton, &c., &c. N.B. We pass'd over y^{e} River at Lifford, the County Town of Donegal; as Omagh. In coming down to the Bridge I observed y^{e} stones full of a lustre-like Antimony. Qu. if Lead may not be had here.

"July 5th.—N.B. The Mountain of Sleaver-Snaght (i. e. Snowdon) is the highest in Inchowen: on the top whereof, saies M^{r} M^{c}Manus, there are beds of Shells (of Oysters, Cockles, and Muscles), w^{ch} have laid there since Noah's Flood, and have alwaies a moisture on em at High Water.—Qu.

"Aug. 5.—I agreed to grant M^{r} Cary a Lease of Coal Mines on Maghery-Moor, in y^{e} Parish of Banacher, at a rent of every 21^{n} Corf.—Oysters on several Mountains.

"Aug. 8.—Takeing Leave, we went hence (25 Horsemen) to y^{e} E. of Antrim's whimsical Castle of Dunluce, on a rotten rock in y^{e} sea, whence (two or three miles further) to y^{e} stupendous Giant's Causeway. It's plainly a range of extraordinary Columns of Stone tumbled headlong into y^{e} Sea from y^{e} neighbouring Rocks, which are visibly of y^{e} like strata of multangular-pillars, Squares, Pentagons, Hexagons, &c. The most notorious of these are the Organs, Giant's Chair, Looms, &c. Hence through lightning and rain we were conducted to Ballymoney by M^{r} Matthews; at whose house (Prospect,) I lodg'd, wth my B^{r}, D^{r} Benson, and M^{r} Gage.

"Aug. 9.—By Maghresharkin and Maghrehoghil (where we dined, and parted wth M^{r} Winder,) we came to Antrim; along the Head of y^{e} mighty Lake of Neagh (or Birds), 20 miles in length and 14 in breadth. Here are y^{e} famous hones for razors, grey trouts and skellies (here called pollons), as in Hull's Water. It empties itself into Loch Beg, or y^{e} Little Loch, and that into the Bann."

Several notices are found in the Journal of successful seal-hunting at Culmore, which appears to have been, at that time, an ordinary place of resort for those mammals.

Bishop Nicolson and the Rev. Mr. Innes visited also Tircreven Burn, and examined its fossils. The existence of recent marine shells on the summit of Slieve Snaght, is a fact yet to be verified; though in the analogous case of Knocknarea, in the County of Sligo (1078 feet above the sea), such shells, the common cardium, have been found, and lead to speculation as to the manner in which they arrived there, no traces of a neighbouring level sandy bay of corresponding altitude, in which they could have lived, having been discovered. It may be added that Bishop Nicolson was known and esteemed as a man of science before his removal to Ireland; the second letter of Edward Lhuyd (1698), "de encrino Lachmundi, Entrocho Agricolæ, Asteria altera, Staffordiensi Plotii, aliisque rarioris notæ lapidibus è Cumbria acceptis;" in which he maintains the affinity of encrini to star-fishes, having been addressed to him when Archdeacon of Carlisle.

CHAPTER III.

PHYSICAL FEATURES.

It has been correctly observed by Mr. De la Beche that a notice of the physical features of a country, or of "the present state to which a given portion of the earth's surface has been brought by the varied and successive geological changes that have occurred upon it, would, probably, be more strictly in place if it followed rather than preceded any account of the geological events which have produced them." The practical advantage, however, of knowing something of the general form and circumstances of the surface, induced Mr. De la Beche, to conform to the ordinary plan of geologists, and the same reasons are here considered equally cogent. To give such a view of the features of a country as should bring them distinctly before the mind is, however, a matter of difficulty, as their appearance necessarily varies with the conditions under which they are observed: the country which seen from an elevation is considered level and unbroken, assuming, when examined closely, the character of undulations more or less sudden according to circumstances; hence, in a practical point of view, it is desirable to form some idea of the face of the country under both these aspects. If examined from a point of sufficient elevation, for example, Sawel, 2236 feet, or Muinard, 2064, some striking peculiarities are perceived; the mountains and hills of mica schist, which occupy the west of Derry, and from below seem a continuous range extending N. and S., now separate into distinct members, as portions of successive ridges lying E. and W., being continued on the one hand, though with a wide interval, in Antrim and Scotland, and on the other, with similar intervals, in Tyrone and Donegal. The great mica schist system, therefore, which once extended with an E. and W. strike for more than 200 miles, has been broken up and reduced to those isolated masses alone, which have resisted the destroying forces acting against them; and were it possible to remove the superficial covering of secondary rocks, they would, without doubt, be found connected together by intervening fragments of the same strata reduced to a level so low as to be covered up by subsequent deposits—portions of such connecting links or reefs, are in fact seen in Balteagh parish. The ridges which enter into the composition of these masses are smooth, rounded, and flat-topped, such as Muinard, with occasional mountain eminences of a more conical, though still rounded form, such as Sawel and Moilaghash ; their sides and summits are usually boggy, but on the southern face, or face of outcrop, there are many spots of green and wholesome pasture. They impress upon the country within their limits a character of strongly marked longitudinal valleys, wide where the softer materials of some of the beds have suffered extensive wear, or there has been a considerable interval of time between the deposition of the successive ridges ; narrow where they represent the divisions between similar and closely succeeding beds ; but all these appearances have been further modified by repetitions of disturbance and detritic action, the valleys being rarely if ever exactly in the strike of the strata. Legavannon, Slieve Buck, and Slieve Kirk, to the north, and Muinard, Sawel, and Stra, to the south, are fine examples of these nearly parallel ridges. If the hilly country be examined in a direction transverse to the strata, it will be found to exhibit in succession sharp rises, and boggy flats, corresponding to the several outcrops ; following one of these flats in a longitudinal direction, the observer moves on a plain, but crossing the ridges he discovers its true character ; and in this manner will his opinion of the hilly or level nature of the country be influenced by the direction in which he travels. Had no secondary strata been deposited, the mountain district of Derry and Tyrone would therefore have stood out boldly from a surrounding plain ; its sides being deeply indented by bays penetrating into its stratification, and its ridges being connected with those of Antrim and Donegal, by chains or reefs of rocks and islands : the secondary strata, however, have been deposited, then covered in part by basalt, and subjected to detritic action, thus completing the elements of the present configuration of the surface. Looking northward from Muinard, the minor features of the country melt away, and there appears a deep re-entering bay, bounded on the west by the primary schists which extend into Ennishowen, and on the east by a steep and broken range of basaltic capped secondary strata. Lough Foyle occupies only a portion of this bay; but the deeply indented outline of the basaltic and secondary cliffs, exhibiting as it were so many minor bays or inlets, marks its more ancient extension (See pl. B.). Viewed on a level below, the surface of the bay, occupied by readily decomposing grits and by detritus, is gently undulating. It receives the tributary streams of the Roe, which discharges into Lough Foyle. The Faughan, cut off from it by an intervening rise, having passed through another internal expansion of similar bay-like character, arrives at Lough Foyle, its course being in part transverse to the schists, and in part parallel to their strike. The usual character of the last detritic modification of the surface, may be traced in all these bays and streams, viz., sandy or gravelly flats with retired banks; the present streams occupying beds cut in the former detritic plains.

Shifting to Slieve Gallion, and looking eastward, the secondary or basaltic range still continues its course towards Tyrone and Lough Neagh; but it is here low, being separated from the elevated patch on Slieve Gallion Cairn, by a deep valley of denudation; beyond is the flat of Lough Neagh, and in the distance the range of Antrim hills. Descending to the plain below, the same undulating surface is met with, breaking into longer hills where the strata are more persistent, and assuming more rounded forms, where they are soft or detritic; and in the N.E. of Derry the interest of these appearances is heightened by knolls of basalt and heaps of gravel like the escars of the western counties, producing a very curious combination of islands and lough-like flats. The ancient indentation of the line of the primary schists, prior to the deposition of the secondary strata, is strongly marked (See *Views*, pl. D.), in the Vale of Ballynascreen; one extremity of which is boldly terminated by the lofty and isolated mass of Slieve Gallion. The Moyola and its tributaries are collected here and discharged into Lough Neagh. On the Tyrone side, the syenitic and metamorphic rocks of Slieve Gallion extend in a low pinnacled range southwestward; and the old red sandstone, penetrated and indurated by numerous trap dykes, forms a distinct ridge stretching westward from Pomeroy to Lough Erne, its summit levels separating into undulating hills, rounded and modified by detritic action, but yet retaining a longitudinal character. South of this are detached portions of a ridge of carboniferous grits, and the shales and limestones of the same system contribute to form a surface, varied by rounded hills and embosomed flats, with glassy pools and winding streams, possessing all the elements of a quiet picturesque. The same characters of rounded hills and lough-like flats, may again be traced on the east of Lough Erne; the harder grits here also, as at Formil, rising above the levels of the shales and limestones; but on the western side, all is changed, and the carboniferous strata rise into lofty precipices, rivalling in grandeur the basaltic cliffs of Antrim.

This sketch will probably convey a tolerable idea of the present condition of the surface, and of its progressive modifications; by the wear, or denudation of the mica schists, as exhibited by the detached character and broken outline of its masses, by the deposition of the secondary strata filling up the inequalities thus produced, as shown by the portions still extending into and covering over the re-entering angles of the schists: by the outpouring of volcanic mud and basalt, forming a solid and protecting covering to the more perishable strata; by the attacks of the ocean on these newly formed cliffs, the removal of the soft sub-strata, the fracture and fall of the now unsupported basaltic cap, and the formation of a long line of indented cliff, with its bays and head-lands; and, finally, by the modifications consequent on long-continued aqueous agency, the formation of gravel and sand, and their arrangement sometimes in level flats, and sometimes in rounded hills. It will be concluded by a few practical remarks.

The geological configuration of the country has an important effect on road-making. Were it not for the great amount of transverse wear in the mica schist, commercial communication N. and S., within its range, would be almost impracticable; and even as it is, the steep ascent at the commencement of the road from Derry to Claudy, is a sufficiently striking example of the original difficulty. Selecting the natural valleys, communication becomes more easy: the valley of the Foyle affords an easy passage from Derry to the plain of Donegal; the latter portion of the course of the Faughan is through a similar valley; the road from Dungiven to Claudy is also easy from the same circumstances; whilst the old roads, from Dungiven to Maghera and to Draperstown, are good examples of the up-and-down system of crossing strata in their line of dip. To the east, the communications of the city of Derry are obstructed by the chalk and basaltic cliffs, running transverse to the strike of the schists, and therefore closing up what they would have left open; and in this case there is only a choice of difficulties, to select the easiest opening through the "Barrier." A road running, however, in its direction, should as nearly as possible conform to it; and on this principle the new road to Maghera from Dungiven, has left the edges of the schists, with all their rises and falls, and now pursues the line of the secondary cliff at a uniform level, until it is obliged to descend to the plain below. In districts of limestone and soft grits, or in detritic districts, road-making becomes troublesome, as the lines must be carried from right to left, so as to wind round the rounded hills and keep in the flats between them, becoming tortuous, if good; see, for example, all the improved roads of the low country of Derry, Tyrone, and Fermanagh.

The features of the country exercise also a powerful influence (Int. Rem. p. 1, 2.) on the commercial prosperity of towns, which are the great marts for exchanging the products of industry, by limiting the field of their supply; in this manner the basaltic range in the east, and the schist mountains on the south, cut off a large portion of the country from Derry, and turn its products to Coleraine or to Belfast; the greater portion of the plain of Donegal, however, remains open to it, and it is in that direction that efforts should be made to improve communications, and to spread more widely the range of demand and supply.

By an approximate consideration of the natural limits of their several productive basins, it appears that

	Sq. miles.		Acres.
Coleraine should command the supply of	353	or	222,576
Derry, „ „ „	678	„	443,392
Belfast, „ „ „	1988	„	1,127,232

Hence they would stand to each other as receiving marts, in the ratio of 1—1.9—5.6, if the numbers were not modified by the superior advantages possessed by the one over the other as a shipping port. The Report of the Railway Commissioners, represents the exports of the three places, as amounting to:—

	Tons.		£.
Coleraine,	7,500	in value	110,000
Derry,	37,000	,,	1,050,000
Belfast,	65,000	,,	4,400,000

Or proportionately in value as 1—8.5—40: hence the proportion of Derry to Coleraine, is augmented from less than double to more than nine times; whilst that of Belfast to Derry is only raised from about three times to a little more than four times; an augmentation to be ascribed partly to the greater amount of manufactures in Belfast, partly to its more improved agriculture and communications, and partly also to the fact that it receives a portion of the natural supply of Coleraine. The imports, are represented in the same documents:—

	Tons.		£
Coleraine,	8,500	in value	70,000
Derry,	70,000	,,	710,000
Belfast,	250,000	,,	3,750,000

Or the value in proportional numbers, as 1—10—53.5; in which the ratio of Belfast to Derry, is still further raised from three to more than five times, in part a result of the great importation of fuel and the raw material for its manufactories.

This comparison is on the whole not unfavorable to Derry, and should encourage its wealthy merchants to make those exertions for facilitating the arrival at its port of internal, and distributing more widely external produce, in order to derive the full advantages of its favorable position.

In respect to Coleraine, it shows that much has yet to be done to render its markets and port, the latter having the disadvantage of distance from the town, sufficiently attractive to prevent the farmer resorting to Belfast; the advantages of a larger market preponderating over the disadvantages of increased distance, and the passage of a natural boundary, not in this instance so strongly marked as in that between Coleraine and Derry.

The artificial modification of the surface by its cultivation, may be estimated from the following table, compiled from twenty-nine parishes in the County of Derry.

In Twenty-nine Parishes, the Acreage of which amounts to 386,120, there are :—

3,244·4	of Wheat.
2,525·1	Barley.
68,382.	Oats.
490·9	Rye.
6,187·2	Flax.
34,592·1	Potatoes.
821·6	Turnips, M. Wurzel, Carrots, &c.
1,144·4	Leguminous crops.
64,025·2	Pasture, fallow.
11,760·4	Meadow.
210.	Meadow and Pasture, the quantities of each not discriminated.
4,117·9	Plantations.
514·6	The greater portion of this is Gardens.
7,115·9	Roads.
180,988·3	Mountain Pasture, Bog, Waste, &c.
386,120.	Total.

The value of the crude products of the soil on this space, independent of any augmentation by their manufacture into animal food, clothing, &c., cannot be estimated at less than £1,050,000, which may be taken as a scale of comparison for the general fields of supply.

The influence of the physical features on climate is also most important, and requires to be locally more attended to, as nothing is more striking than the ignorance which so generally prevails amongst farmers, on the peculiarities in this respect, of their several localities. The number of rainy days in each agricultural district, and their monthly distribution, are most valuable data to the farmer; and as they vary considerably according to the circumstances of the country, they should be carefully ascertained. A table of this kind, constructed from observations made under the direction of Mr. Wilkinson, Architect to the Poor Law Commission, will be given in the Appendix; but so easy a mode of estimating the proper epochs of agricultural operations should not be neglected by the humblest farmer, and the certainty derived from its results would amply repay him for the little trouble it had required.

CHAPTER IV.

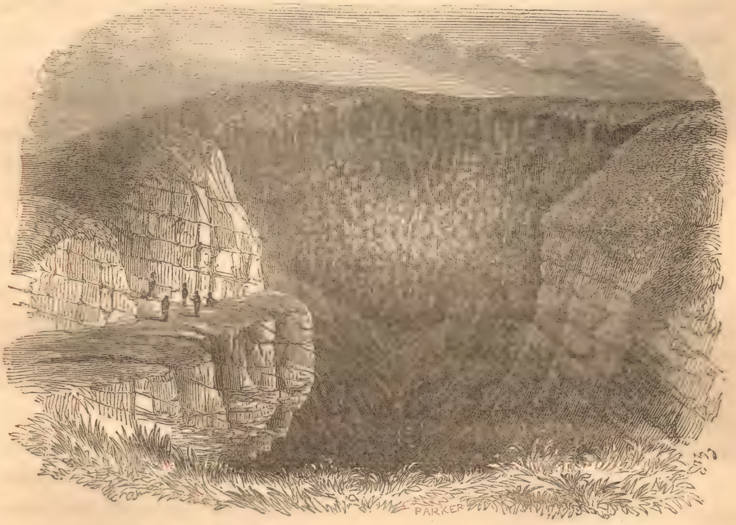
STRATA UNDERLYING THE BASALT, FROM THE CHALK TO THE NEW RED SANDSTONE, INCLUSIVE.

No. 3.

ALTHOUGH on the present occasion I do not purpose to enter fully into an examination of the chalk, with a view to determine what minor subdivisions are practicable within its general boundaries (such consideration being better fitted for the County of Antrim), enough will be stated to prove that as a geological horizon, it is more distinct and clear of difficulties than any other system of strata within our district; and on that ground it is selected as a starting point. The strata will be followed in a descending order, so far as the new red sandstone; the basalt and tertiary deposits will next be described, in order to complete the history of the upper strata, and then the order will be reversed, and the description proceed, from the underlying mica schist to the carboniferous strata, and finally a brief notice will be given of the detritus.

It has been said that no material change has been effected on the secondary strata by the overlying trap rocks; but this remark though partly correct in respect to one class of change, namely, from a compact to a crystalline structure, is by no means so in respect to other changes, both mechanical and chemical. The assumption of a crystalline structure by rocks in the vicinity of trap dykes is, at least in part, the result of a polarizing action which such narrow lines of melted stony matter, having a definite direction for a considerable distance, may reasonably be expected to exercise. The appearances visible at or near the junction of the overlying trap and the secondary rocks, are in general of a different character, and will be best appreciated by following the boundary of the basalt, and noticing the various points of contact it affords. To do this with more advantage and ease, all the strata which usually underlie the basalt, from the chalk to the new red sandstone, inclusive, will be noticed in this review of the connexion of the basalt and secondary strata. Beginning at Ballycastle, beyond the limits of this memoir, the chalk and basalt are found in immediate contact on the sea-shore west of the harbour. At the lowest point, and rising from the sea into a pinnacle close to the harbour, is a mass of rudely columnar trap, the columns having a diameter of 3—6 ft.; it corresponds to the highly crystalline traps of Fair Head and Portrush; within, and partly resting on this, is a small portion of chalk of a conglomeritic structure, being composed of a hardened calcareous paste, in which are imbedded fragments of chalk and flint of various sizes, some very small, others more than a foot thick, together with trap pebbles, ovate in form, and not exceeding five inches in length. There is no confusion or mixture of the crystalline trap and conglomerate. Another remarkable conglomerate appears as a paste of ochre or bole, containing flints. Within this is the overlying trap which at its base graduates through an ochreous amygdaloid into the paste of the conglomerate, and also contains minute fragments of flints. The flints in the ochreous paste are much reddened. Flints are again found involved in the trap which here weathers into nodular lumps, and the chalk is domed over by the trap, a layer of a confusedly crystalline breccia of fragments of flints and carbonate of lime occurring at the junction. Proceeding along the coast, the chalk rises higher in the bank, its surface being irregularly jagged and surmounted by the ochreous flinty conglomerate; whilst at another place one of its peaks rises into a more indurated ochreous trap, and contains immersed in its own substance, several masses of the trap and ochreous conglomerate. The chalk is of a pinkish hue, and very splintery and greasy on the surfaces of natural fracture. Here, too, the ochreous conglomerate is seen on the shore, and a vein, half-an-inch thick, of the pure chalk, penetrates it, though visible only for about two feet. The phenomena described indicate very considerable effects both chemical and mechanical, repeated it is possible more than once. At Ballintoy, ochre or ochreous trap may be observed immersed in the chalk. At the White Rocks, east of Portrush, all the lower portion of the chalk is very hard, splintery, and full of flints; belemnites are abundant in patches, but fossils generally are not abundant. The facts here exhibited are of great interest.

No. 4.



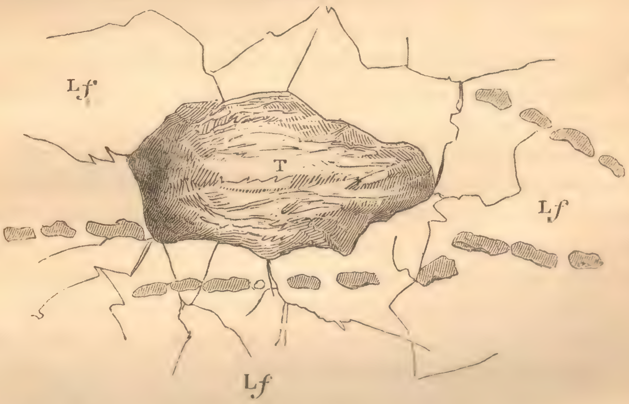
Entering from the Portrush strand an arch in the chalk, and passing through it, a deep hollow is observed at the top of the chalk, which is entirely filled by the massive overlying trap. At the contact phenomena similar to those of Ballycastle are observed; the trap penetrates into the chalk, and forms a conglomerate with the flints and fragments of chalk it has in its progress enveloped. Many, but not all, the flints are changed to red, and the chalk fragments are comparatively few, the lime having, it is probable, contributed to form the enveloping paste, which is in part rotten and soapy. Some of the immersed fragments of chalk are powdery to the touch, though still retaining a definite form, and such is also the case with flints. The great body of the trap is here concretionary; and as the softer portions wear away, the harder projecting lumps look like huge boulders in a rude conglomerate. The bottom portion is obscured by rubbish, so that it is impossible to say whether the trap has risen through the gap as through a crater, or has been poured into it from above; but on the east side the chalk, in a considerable mass, rests upon trap, and is at the same time overlaid by it.

Independently of these phenomena of contact, there are several remarkable examples of large lumps of hard black basalt isolated in the chalk. One of these, of considerable size, near the western end of the White Rocks, is about 25 feet above the shore, and was noticed by Dr. Buckland: it is exposed to view on one side by the wearing away of the chalk. Since the sketch was taken the upper portion of the chalk has fallen, and the huge lump of basalt is now uncovered.

No. 5.

In the cave below the quarry another oblong rounded lump of the same hard basalt, about 18 inches long, is seen partially imbedded in the chalk, and near it is another similar in size, form, and substance, but now detached, the chalk having been entirely worn away. East of the arch is a larger lump, three feet in diameter, which is more than half imbedded, and as the chalk and flints conform in arrangement to its outline, it exhibits the appearance of a fused lump which had fallen into a paste of chalk and flints.

No. 6.



In addition to such lumps, still in part imbedded in the chalk, there are many others which in all probability have been similarly situated. Dr. Buckland remarks that it is difficult to account for the occurrence of an isolated mass of basalt in the chalk; and this difficulty is increased when several lumps, as in the instances detailed, are found at very different elevations, the smaller lumps being twenty feet lower in the chalk than the large one. In what way, then, were they introduced? There is no vein or fissure of any kind by which they could have been connected with any larger mass; hence they must have arrived as perfectly detached fragments, and either rolled in as boulders from pre-existing trap rocks, or, which is more probable from all the appearances connected with them, have been projected from an adjacent focus of eruption, and on falling, sunk into the chalky paste prior to its ultimate induration.* The strata of the chalk can readily, from the lines of flints, be determined to dip inwards at a small angle; and they are traversed by deep fissures of cleavage, the surfaces of which are highly inclined transverse to the planes of dip, and very irregular or rough.

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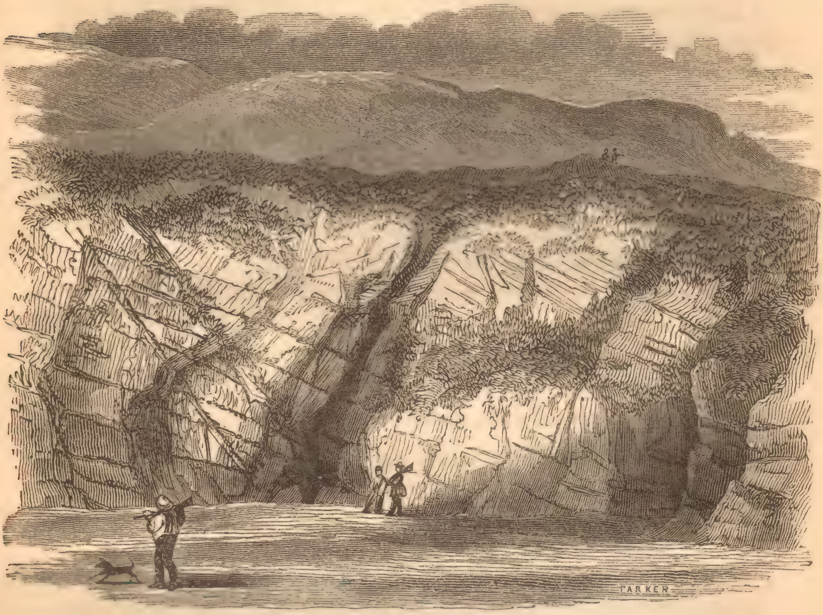
* See also Griffith, Geol. Trans. 1840, p. 185.

No. 7.

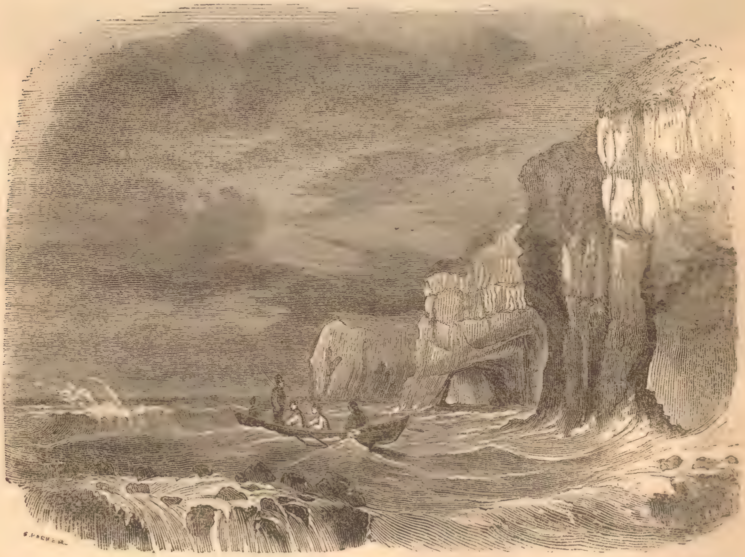


This great irregularity, though doubtless augmented by the wearing effects of the sea as it at former periods (and it does so, though less extensively, now), beat against the cliffs, and enlarged crevices into caverns, is probably in part original, and tends to show that such cleavages were accompanied by a rending asunder of the strata; one of these is figured in the accompanying cut; it was probably at one time entirely filled with basalt or lava, as towards the summit it is still occupied by a portion of that rock. The black appearance of the basalt contrasts strongly with the chalk, and it is so rotten that, on throwing up heavy lumps of rock, fragments of it are easily detached. This, therefore, is a very striking example of a crevice in the chalk, still partly, and probably at one time entirely filled with basalt; but whether that basalt flowed in from above or was erupted from below, cannot be determined;

taking it, however, in connexion with the isolated and imbedded lumps of very hard basalt, it appears probable that some of the eruptions took place prior to the induration of the chalk, that the chalky paste was then gradually indurated, and afterwards fissured by later eruptions.

The constant beating of the sea against this line of cliff, from Dunluce to the strand of Portrush, has worn the chalk into forms of great variety and beauty; pinnacles, arches, and caverns, are combined together, and the effect augmented by the striking contrast of the pure white of the chalk and the deep black of the adjacent basalt. Arch, too, may be seen over arch, indicating perhaps a change of level and successive periods of destruction. Such then are the White Rocks of Dunluce, at once invested with all the charms of picturesque beauty and of geological speculation. The chalk cliff sinking in altitude at the strand is lost under the drifted sand, but can be traced to a point (where it has been quarried) immediately south of Portrush, and then (as well as the lias) it becomes a link in the geology of that remarkable locality.—(*See Cuts*, 3, 8.)

No. 8.

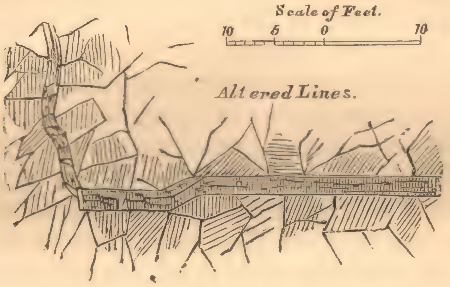


REMARKS ON PORTRUSH.—The extracts from preceding writers (pages 39—45) have already made known the leading facts connected with the geology of this remarkable locality; and yet the more it is examined and reflected upon, the more interesting are the speculations which flow from it. The true position of the metamorphosed lias was established by Mr. Bryce, who first pointed out that, as a whole, it rests on the massive crystalline augitic rock which forms the basement of the promontory; and following up that idea, Mr. Griffith separated the igneous rock of Portrush from the overlying basalts, and classed it with the crystalline greenstones and other erupted rocks. This view of the subject, though in part correct, does not embrace all the phenomena, and tends to obscure the perception of those relations which exist between erupted rocks which have penetrated the crust of the earth and flowed over the sedimentary deposits on its surface, and those which, although they have elevated and fissured the superincumbent strata, have not actually flowed over them. In looking at the great overlying masses of trap, constituted as they are of numerous successive beds, some of which exhibit distinguishing peculiarities either of structure or of composition, it must have struck every observer how difficult it is to connect them with any focus or centre of eruption; and if rocks occupying the position of those of Portrush and Fair Head be separated from them and removed to another class, such connexion would be impossible. The rocks of Portrush and Fair Head are rich in all the elements of basaltic rocks, whilst they exhibit those modifications of structure which might be expected from their peculiar position and circumstances. They bear a relation to the overlying traps not unlike that of granite to the crystalline stratified rocks, and whilst the ancient idea of an igneous origin for the latter has been abandoned in favor of a metamorphic, it is not improbable that metamorphic action will be also traced extensively amongst the strata associated with the basalts. They are also important as connecting links with trap dykes, many of which they strikingly resemble; but they are distinct from the more extensive masses of hornblendic rocks, such as those which occur at Slieve Gallion, and alternate with mica schist in other parts of Derry and in Tyrone, such rocks being of metamorphic origin, as shown by their bedding, cleavage, and position. These preliminary remarks will lead to an expectation of meeting something more in Portrush than the mere juxta-position of an igneous rock and of indurated fossiliferous strata; and such is actually the case, as every gradation of metamorphic change from the siliceous chert-like strata, replete with organic remains, to the highly crystalline rock may be there distinctly traced. But first as to the position of the metamorphosed organic strata. It has been already stated (page 42) that Dr. Buckland first noticed the lias of Ballintoy, and identified it with the indurated organic strata of Portrush, to which may now be added the lias of Magilligan as another link of the broken chain of this deposit. The chalk strata, of the White Rocks, which visibly extend from Dunluce to the Portrush strand, are still continued westward, though hidden either by sand or by ordinary detritus. About half a mile immediately south of the promontory, a quarry was opened and worked for a short time in this chalk; it is there splintery, like the portion immediately on the sea-shore at the White Rocks, and exhibits like it a perpendicular face to the north. The line of cliff, therefore, though probably worn by aqueous action in the interval, does not appear in this space to have suffered much disturbance from below. A little farther to the west an indurated clay occurs under the basalt, which possibly may belong to the lias, but this is uncertain. The strata of the chalk basset, therefore, to the north, and dip to the south; the indurated organic strata, as seen on the Skerry Islands, dip also to the south, and therefore conformably underlie the chalk; but on the promontory itself they dip to the eastward, being conformable to the bedding of the igneous rock. Taking these facts together, it is highly probable that this eruption of igneous rocky matter amongst the calcareous clays of the lias either took place prior to the deposition of the chalk, or that the elevating force was comparatively small and local. The augitic rock appears in its highest or normal state of development at the north-west of the island, where it is traversed by numerous fissures, and becomes in consequence rudely columnar, the tops of the columns inclining eastward, so that the bedding has even here an inclination to the east; the surface, however, is rough and uneven, and the columns rise immediately from the sea to the highest point of the promontory. On the east of the promontory it sinks to a lower level, and assumes a decidedly bedded character, being spread out in sheets having an even and regular surface. Between this rock of a distinctly igneous character and the metamorphosed lias, may be traced several gradations, indicating a passage from the one to the other, and all this intermediate portion is probably metamorphic. The rock of intermediate character occurs in detached portions on the south, close to the sea, near the terrace, but it rises into a distinct ridge near to and west of the Bath House, and extends in a northern direction, or parallel to the principal north-western elevated ridge, to within a short distance of the shore where the more crystalline rock appears at a low level, and such also is its position relative to the crystalline rock on the north-east corner. On the Skerries the appearances are the same; the siliceous or metamorphosed strata on the south, then a semi-crystalline rock with a bedded character, similar to that of the centre of the promontory, and finally, a highly crystalline and augitic bed; here also may be observed beautiful examples of passage from the one to the other, fissures passing through the successive beds so as to divide them into angular or columnar fragments, one portion of which is in the condition of the hardened schist, the other in that of the crystalline rocks; and further, the veins also afford evidence of a metamorphic change; they traverse the rock, in its first stage of alteration from the hardened schist, in a very curious manner (see next page, cut 9), and though looking externally even and black, like lydian stone, they are found, when fractured, to be small crystalline; an appearance extremely similar to some of the phenomena described by Keilhau.

The thickness of the hardened schist is variable; at its highest elevation on the west of the promontory it is from three to four feet, but on the eastern shore varying from six to eight, the two portions being separated by the intervening semi-crystalline rock. Along the ridge of this latter rock there is no trace of the hardened schist, hence this portion must have penetrated through the shales, or must represent some portion of them in a more advanced stage of metamorphosis.

The fossils which are necessary to connect the altered rock with the calcareous shales of Ballintoy, are difficult of identification in their present condition. The most numerous are the Ammonites, of which there are several species, as A. intermedius, (n.s.) and A. Macdonnellii (n.s.), which are also found in the soft shales, and

No. 9.



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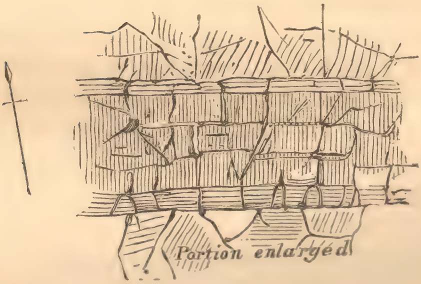


though others are too compressed or changed to admit of positive identification, their similarity of form to those of Ballintoy does not admit of doubt. Pectens, both ribbed and smooth, are tolerably abundant, and they are also evidently the same as those of Ballintoy: a small lima, probably L. pectinoides, is equally abundant in each deposit: Lima alternans has occurred in each: a single valve of a terebratula, corresponds also to those of Ballintoy: Pholadomya ventricosa, a young specimen, the species occurring at Ballintoy: Unios (Pachyodon), though crushed, evidently correspond to some of those of the true lias—probably Pachyodon crassiusculus: and the shell supposed to represent Panopœa elongata (Roemer), is common to Ballintoy, Ballymaglin in Aghanloo parish, and Portrush, as well as some others which will be mentioned in the fossil lists.

Though some of these specimens would not of themselves admit of determination, their identity cannot be doubted when compared with those of Ballintoy; and the great mass of the unchanged rock being a calcareous marl, the change, even in this respect, has been a very interesting one.

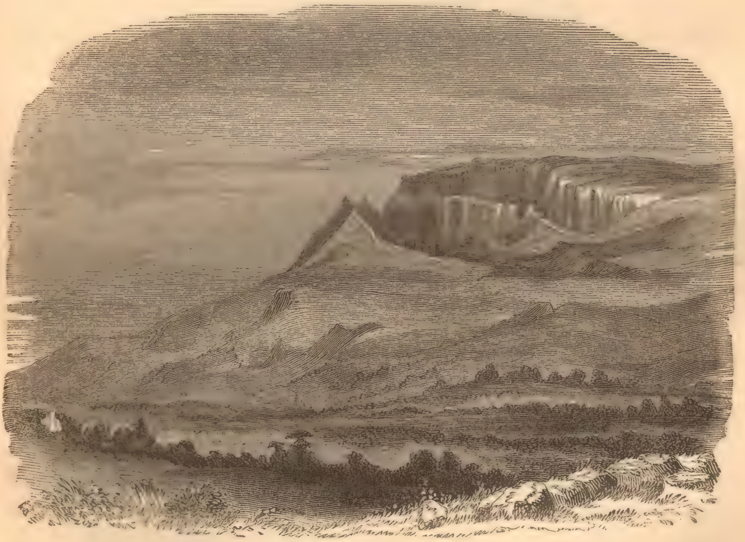
No. 10.

Between Portrush and Down Hill no secondary strata appear, although the occurrence of fragments of trias grit and indurated lias with their fossils on the Bann river renders it probable that some such strata do there exist, though concealed by the overlying basalt and detritus. The outline of the basaltic coast is irregular, and much broken; and the wear, which at former periods must have been very great, is still continuing, the ochreous amygdaloid being comparatively easy of decomposition; and this irregularity adds much to the beauty of the scenery, as may be perceived at the very pretty bathing town of Port Stewart. At Down Hill the basalt assumes an air of grandeur, and west of it the chalk is seen on the shore—at first level with the sea, and then at the base of the basaltic precipice—the total thickness being about 50 feet. Though concealed in part by a bank of sand heaped up against the face of the basaltic cliff, enough of the chalk is seen to show that its surface is very irregular—the hollows being filled up, and the peaks covered by an ochreous flinty conglomerate, which is here, as elsewhere, interposed between the chalk and overlying basalt. The Piper's Cave penetrates through the chalk into this conglomerate, which proves that it is not confined merely to the visible surface. At the gap of Carnowry, which terminates in a very beautiful fall, formed of successive cascades, the ochreous conglomerate and basalt are seen in contact, and exhibit many of the usual phenomena. The basalt penetrates as a vein into the conglomerate, and small fragments of flint are found in an amygdaloid, which, as at Ballycastle, graduates into the ochreous conglomerate. Some flints are reddened; others have the dull white look of unglazed porcelain; and some are so shivered as to separate into thin flakes or laminæ. What appears to have been chalk no longer effervesces, and the trap itself breaks into small cubical fragments. All, therefore, indicates important chemical and mechanical changes. The chalk of Down Hill has been supposed to rise to the west; but this is an error. The bed seen on the sea-shore is distant from the base of the precipice about 100 yards, and underlies the more elevated beds, which, together with their basaltic covering, have been thrown back from the sea by long continued wear. Sea-ward of the chalk is a line of huge fragments of basalt, looking, as the sea breaks over them, like so many stranded whales; these are relics of the ancient line of precipice, and extend to Down Hill, where, their number being increased, they lie confusedly together, and of all sizes—some ten, some twenty, some thirty feet long. The actual dip of the chalk beds is to the S.E. (S. 30° E.) at a small angle of 9°, and they evidently form part of the northern boundary of the chalk basin, together with the chalk of Ballintoy, Bushmills, Dunluce, and Portrush; whilst the chalk of Ben Evenagh, Keady, Donald's Hill, &c., is part of its western boundary. An isolated pinnacle and a massive arch, worn through the basalt at Down Hill, and the caves in the chalk of Magilligan, are indications of the continued destructive action of the sea, whilst the numerous and deep fissures which intersect the face of the precipices of Magilligan and Ben Evenagh, each with its feathery waterfall, mark the auxiliary aid of atmospheric agencies. Of the chalk caves, that called the Piper's Cave is the principal; its base is more than five feet above the present high-water level, and, like all the other caverns in the chalk, it may be considered a cleavage fissure enlarged by the sea. At its entrance it is 5 ft. 6 in.

high, and 12 ft. broad, being stopped up in part by drift sand, and it extends in nearly a N. and S. direction about 110 feet—the last 11 feet in the ochreous conglomerate. The walls are quite smooth, and stalactitic matter drops from the roof: the floor is covered with the ordinary shore pebbles, mixed at the entrance with limpets, which have probably been brought into it by man. On sinking to the rock, nothing of interest was noticed, and the caves are therefore cited only as further examples of the undermining action of the sea.

Magilligan to the Keady.—Turning from the Magilligan shore towards the north and western faces of Ben Evenagh, the scene acquires new grandeur, and still higher interest. Looking up from below, the face of Ben Evenagh appears encumbered by ponderous and shapeless masses, which in successive stages rise to the base of the steep basaltic summit, and there break into pinnacles and precipitous cliffs.

No. 11.



Standing on one of these, and looking along the face of the mountain, the successive lines of rudely formed hillocks, the steep basaltic face they present to the great mountain precipice, and the various beds of basalt and ochre which occur in each—

together with the isolated pinnacles which yet remain on some of them—attest their former position; and explain the nature

No. 12.

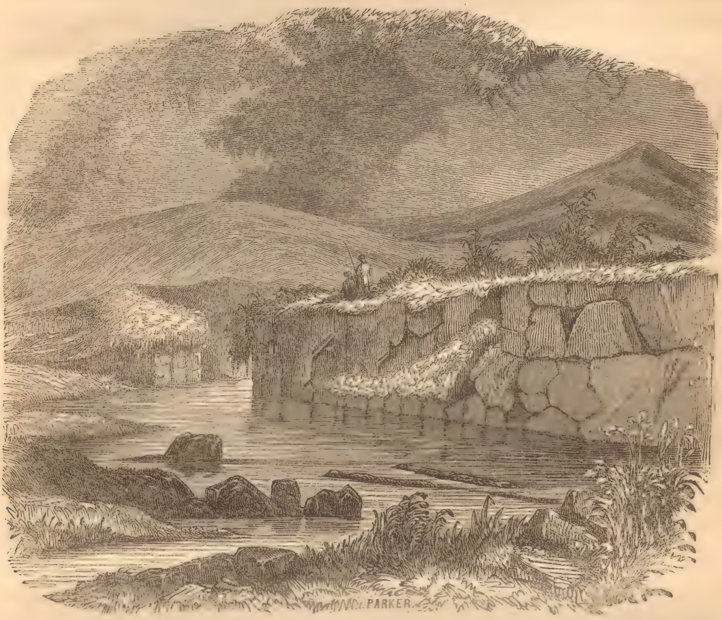
of these vast landslips, and of this undercliff of surpassing magnificence, connected as it is with the basaltic summit of Ben Evenagh rising to the height of 1260 feet above the sea. The cause of these slips is perfectly simple, and the same as in the well known examples of England, as will be understood from a review of the stratification which here embraces all the strata from the new red sandstone to the chalk.

The lower portion of this section is seen to advantage, and can be traced upwards, in the small stream which, descending from Stradreagh waterfall, separates the townland of Lisnagrib and Dirtagh, and having joined the boundary stream of Drumachose and Aghanloo parishes, crosses the new road from Newtown Limavaddy to Bellarena. In the townland of Derrymore, high banks of a deep-red sandstone mark the outcrop of these strata; the structure of the sandstone is variable; at its base there are irregular streaks of small primary pebbles, and it then becomes soft and variegated with greenish-grey spots and lines. At one point the sandstone is hard, and exhibits a curious semi-crystalline structure, which on weathering produces a roughened surface; it there also exhibits lamination transverse to the bedding, and is divided by fissures, which are coated with thin seams of calcspar; but in general it is composed of alternating beds of red and variegated marl, and of red and whitish sandstones, in all more or less, but most of them highly calcareous. Towards the summit, the light coloured, marly, and highly calcareous grit, used by the peasantry (when decomposed) for cleansing and scrubbing their household furniture, prevails, and is succeeded by shales and calcareous grits, which form the transition member between the new red sandstone and the lias—and therefore, in part at least, correspond, as their fossils do, to the muschelkalk. This system of brick-red calcareous grits and marls, variegated with others of a greenish-grey and of a white hue, extends eastward, passing the Curley Burn towards Keady, where it is nearly in contact with the greensand, or lower member of the chalk.

No. 13.

In the deep re-entering angle between Ben Evenagh and Keady, the upper marly beds are evidently indurated by metamorphic action; and on approaching the celebrated dyke, called Lady O'Cahan's Bridge, assume a laminar structure parallel to the face of the dyke, and look like an indurated black marly shale. The dyke itself is 6 ft. 9 in. broad, formed of several parallel layers, which are again divided by cross fracture into rectangular lumps, and a concretionary structure is visible in some of the layers.

No. 14.



In this section the whiter grits form several more distinct beds, and it may be added that clay galls or lumps, either soft or indurated, occur occasionally in the sandstone. The whiter grits are also sometimes vesicular from the local removal of the calcareous paste, and the lime is then deposited in crystals in the cavities formed. The upper strata at Lady O'Cahan's Bridge are succeeded by the greensand and chalk, and the extensive denudation which has here exposed to view the strata in the line of dip, not bringing to light any of the oolitic or lias strata, it is evident that the relics of these strata now occupy only a narrow belt-like space along the face of Ben Evenagh, and are not seen farther southward on the western chalk escarpment.—(Pl. A. fig. 3.) The portion which is in nearest proximity to the marls of the new red sandstone, and therefore may be considered the lowest member of the system, as here developed, is that of Lisnagrib. Passing upwards from the sandstone, greyish and partly indurated marls or clays are met with, which form a connecting link between the new red sandstone and the oolitic systems: these are about 17 feet thick; to them succeed alternating beds of dark shale and calcareous grit.

1. Compact blackish even shale, or clay, the bottom of which is not seen.
2. Seam of calcareous grit, about half an inch thick.
3. Black shale, nine inches.
4. Seam of calcareous grit, about half an inch thick, but variable, with impressions of bivalves on one side, and on the other the teeth and scales of fishes, viz., Saurichthys apicalis, Gyrolepis Albertii, Gyrolepis tennistriatus, Acrodus minimus (muschelkalk fossils.
5. Black shale, seven inches.
6. Calcareous gritty shale, in some parts a calcareous grit, with bivalves on the faces of lamination, five inches.
7. Black shale, with Avicula contorta (n.s.) and impressions of Cardium striatulum.

The total visible thickness of this deposit, as seen here, is not more than seven or eight feet; and it may be remarked that the shaly bed, containing the Cardium striatulum, is again found, 40 miles distant, in Colin Glen, near Belfast; but as yet the calcareous grit, with the teeth and scales of fishes, has not been there discovered.

For a short distance to the east of this opening, the country people say they arrive, on sinking through the superficial detritus, at shales; but the formation in that direction then ceases, as has been already shown. In total thickness it must be very inconsiderable—the chalk cropping out immediately above it, and the marls of the new red appearing equally near below it. In a westerly direction, a peculiarly soft, pasty, wet, and slippery surface marks, in several places, the position of the clays, which appear to form the next ascending member of the oolitic formation, and the new red becomes still more marly or clayey in its character, approximating to that of the lias. On the stream which traverses the townland of Tircorran, the clays are associated with shales and a calcareous grit—the grit is fossiliferous containing Plagiostoma gigantea—but this is a very small patch, and as the strata are all dipping downwards, has evidently fallen from its true position; as a portion of the lower chalk or highly indurated greensand near it has also done. Here the ascending order is grit, shale, clay, grit, a thin layer; total thickness visible, 4 ft. 6 in.

In the boundary stream between Aghanloo and Magilligan is clay, with layers of an impure limestone, very smooth in fracture, and Gryphœa incurva here occurs; but it is probably also a slipped portion. From this spot to the Tircreven Burn the chalk and lias are seen in detached patches—not arranged in any one line of strike, but repeated several times in the same line of section, the result of repeated slips which have thus brought the strata down from their true position, and made them to assume the appearance of alternations of the same strata several times repeated.—(Pl. A. fig. 1, 2.) It is easy to perceive how difficult of investigation such a locality as this must be, and how impossible, under such circumstances, to assign very exact limits to any one of strata so much disturbed and displaced. In the Tircreven Burn, however, a mass has hung together of sufficient magnitude to give a tolerable idea of at least a portion of the system.

In the ascending order occurs, first, blue clay, with layers of impure limestone.

2. Yellowish ferrugineous sand, with hard layers of a highly calcareous grit, which abounds in Plagiostoma gigantea, of all sizes from those of two inches in length, having their longitudinal striæ perfect, to others of six inches in length, fragments of a large pinna, P. Hartmanni, and many other fossils.
3. Impure limestone, or indurated calcareous shale, grey and compact, full of Gryphœa incurva, covered by a bed of soft blue shale or clay, with impressions of shells and remains of plants.
4. This appears to be the place of a thin seam of coal sunk to by Lord Bristol.
5. Blue clay, greasy to the feel, which, by becoming sandy, passes into a green sand; it contains Gryphœa incurva.
6. Greensand; the lower portion sandy, and still containing

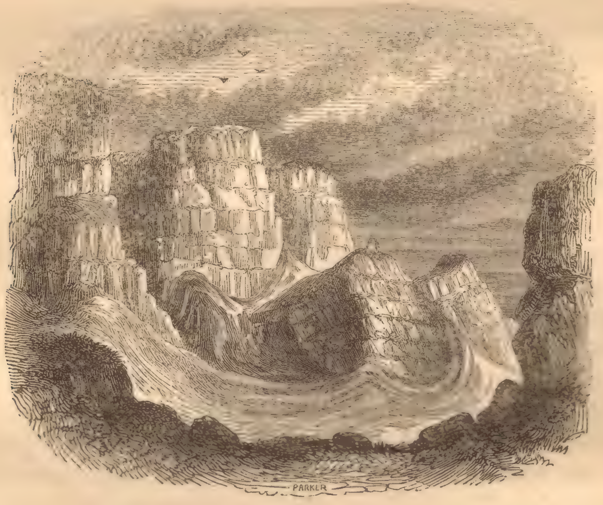
Gryphites; the upper of the usual calcareous form, but though, from the disturbed condition of the strata, the greensand beds, containing Gryphites, the same as those of the subjacent strata, are here in contact with the chloritous chalk, they are, in all probability, portions of the oolitic strata, the true lower greensand containing Pecten quinque-costatus, Gervillia, &c., being found on the eastern chalk escarpment, in the County of Antrim.

7. Chalk, capped by the usual ochreous conglomerate and basalt.

The strata thus detailed do not exceed 30 feet in thickness, and the total thickness of the portion of the oolitic system here exposed, cannot be much more than the same thickness, or from 40 to 50 feet. This, however, is on the supposition that only the well defined clays, grits, and limestones, belong to the lias, and that the marls underneath in all cases belong to the new red sandstone. The calcareous grit affords a very good stone for sharpening scythes; and the country people are said to use some of the shales (which contain much decomposed iron pyrites) medicinally, as tonics. From Tircreven northward, the lias is met in considerable patches, for three-quarters of a mile farther.

This sketch of the stratification of the face of Ben Evenagh, is sufficient to point out the cause of those repeated dislocations and slips, which have heaped around its base an accumulation of gigantic ruins. The chalk, on which the great mass of basalt rests, is here, as on the northern, eastern, and southern borders of the basin, supported either by marls of the new red sandstone, or by clays and shales of the oolites, of great combined thickness. Exposed by denudation to the action of the sea, which formerly stood at levels, decreasing by successive stages in height, from the tertiary (newer pliocene) to the existing epoch, these soft strata were in part washed away, and in part, being moistened by percolating water, were squeezed out from beneath the overlying strata by the great weight of the superincumbent mass, and thus huge fragments, no longer sufficiently supported, separated from the main body of the strata, and slid down to a lower level. Several of these huge landslips are distinguishable, as shown by the sections cited, and by the woodcuts; and it is only necessary to look up at the basaltic precipice above them, and to consider the deep fissures dividing the rock into vast angular fragments, which threaten, as it were, even now to fall, in order to feel that were the sea again to assume its former level, and to clear away the rubbish, which now abuts against and protects the cliff, new landslips would rapidly follow, until the whole of the basaltic mass thus feebly supported had been melted away and hurried into the ocean.

No. 15.



For the lias fossils, see the end of the chapter.

Keady to Donald's Hill.—Resuming the consideration of the chalk and basalt; at Keady the chalk is about 33 feet thick, and rests on about 36 feet of indurated greensand or (as it has been called) mulatto stone, the bottom portion becoming more loose, green, and sandy. The layers of flint in the chalk are about 2 ft. 8 in. apart, and more run together and irregular at the top than at the bottom. The new red rock, or new red sandstone, appears immediately below the greensand. The surface of the chalk is very irregular; and at its junction with the overlying basalt the latter is black, breaking, like coal, into small cubical fragments, and the usual mixture of unctuous ochreous clay, broken pieces of chalk, and calcined flints also occur. The lower portion of the chalk, as seen in one of the quarries of this mountain, is called the soft rock, and is used for manure without burning, as it crumbles into powder when exposed to the air.—(See White's Selborne, Malm Rock.)

Between the Keady and Donald's Hill is another deep indentation or bay, in the chalk escarpment. At Donald's Hill the flints are reddened and form a kind of conglomerate; and where the basalt approaches to a direct contact with the chalk, the chalk is shattered to the depth of 2 ft. 6 in., and assumes a deep pink colour, whilst the basalt itself is laminar or slaty for four feet and then becomes massive. Immediately at the contact is a thin seam of clay, a modification of the basalt. But the most remarkable fact is the occurrence in the chalk of granular, vesicular beds, having the sides of the cavities lined with perfect crystals of carbonate of lime and of quartz. These dolomitic beds, three in number, are associated with the layers of flint, are sandy, only effervesce very slightly, are of an average thickness of 2 ft. 6 in., contain small geodes of chalcedony in the upper layer, and though so evidently the result of metamorphic action are separated by common chalk from an actual contact with the basalt.* At another point a bed of clay with fragments of decomposed basalt fifteen inches thick, (at the top yellow, and below red) intervenes between the harder trap and the flinty conglomerate, the paste of which is of a pinkish hue; and the trap is also laminated. It may be observed that the chalk strata are here from 12 to 20 feet thick, and that the mulatto stone or indurated greensand, is not visible; it is therefore possible that they exhibit a double character, partly of transition to the underlying greensand, and partly metamorphic; and in this case, as in many similar to it, the quantity of silica mixed up with the chalk, is so great as to render it almost useless. A deep bay extends from Donald's Hill to Benbradagh.

Some of the beds in the marly and soft grits, exhibit very remarkable contortions, which are shown to great advantage by the difference of colour between the marls and grits.—(See pl. C. fig. 2.)

Benbradagh to Eden.—The chalk still affords evidence of disturbing and igneous action; on the face of Benbradagh next Dungiven, it is from 12 to 25 feet of visible thickness, and is traversed by layers of flints, about two feet apart: on Eden it dwindles to two and three feet, and is charged with flints; it then thins out and disappears, till on the Ballynascreen side a thin layer of rude flints again marks its level. At the Benbradagh quarry, the chalk is covered with a bed of deep red clay full of flints, which are shattered and calcined, and on this rests the basalt. The chalk itself contains calcspar, quartz, hydro-carbonate of magnesia, &c., and is therefore another example of the chemical effects of contact. In another point the flints appear to have been shattered and re-united, an appearance also noticed on the Craignashoke side; and chalk with flints much altered, occurs in another place, imbedded in the basalt, and at a considerable elevation (about 70 feet,) immediately above the regular line of chalk. On Eden, it assumes a deep pink tint, and the flints are much altered; rolled chalk pebbles are seen at another spot; and slips, both here and on Benbradagh, mark the soft nature of the underlying strata. The hardened greensand is rare and abounds in belemnites; but there is a considerable thickness (Pl. A. fig. 4) of red and greenish marls, and red grits of the poikilitic system, which contain the minute bivalve, Posidonia minuta, associated at Roan Hill (Tyrone), with Palœoniscus catopterus. The red marl is continued in Corick, though cut off by an intervening gap from that of Eden. Plate E. fig. 1, shows the remarkable position of this hill: the cap of basalt being isolated on the grits, the upper portion with marls belonging to the new red (poikilitic), the lower to the carboniferous system. On the face of Eden, opposite to it, a portion of trap apparently in situ, at a lower level, has very probably risen from below. To the east of this portion of the chalk escarpment, in the parish of Errigal, a small patch of the new red marls and grits, with a minute portion of the flinty and hardened chalk above it, emerges from beneath the basaltic cap, and proves, as in the case of Templepatrick in Antrim, the continuity inwards of the chalk basin.

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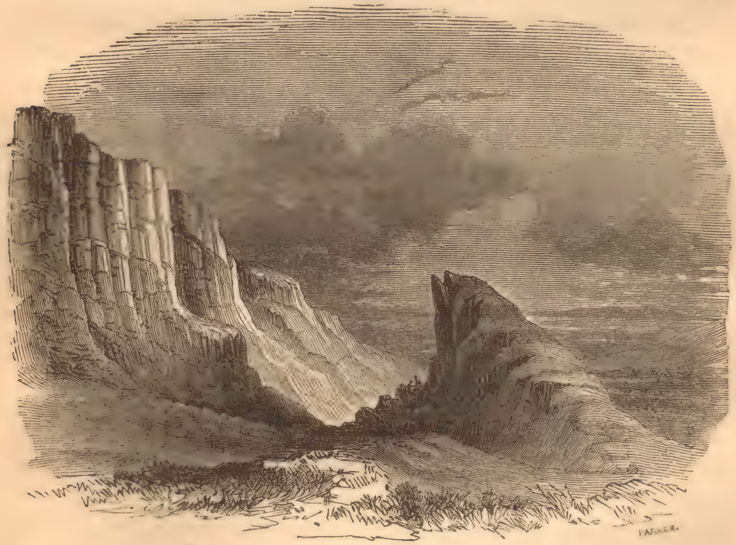
* A variety of stilbite has been discovered by Dr. Moore of Dungiven, in the cavities of ferrugineous flints of this locality.—*(See List of Minerals, ch. 9.)*

Passing over the elevated ground into Ballynascreen parish, the grits of the carboniferous system, as shown by their fossils, are immediately under the basalt; but at one point, on the face of Craignashoke, a thin layer of chalk and flints, ten inches thick, rests on the sandstone, and is between it and the trap; and a few flints can be traced at other points. Here also under the basalt is a bed of lignite 18 inches thick, containing in its pores and cells, small lumps of amber, the existence of which, under such circumstances, is curious, the wood itself appearing to have been charred. This mineral was previously noticed at Rathlin by Sir Charles Giesecke. In a similar position, also under Craignashoke, there is a layer of earthy brown hematite. The lignite is again observed on the Slieve Gallion side, and is there also under the basalt; hence there can be no doubt that the outpouring of this portion of the basalt was subsequent to the growth and destruction of tertiary wood.

The stratification under Craignashoke (Pl. E. fig. 3.), is much obscured by slips and dislocations, and it is extremely difficult to distinguish the true dip of the strata under such circumstances. Some of the slipped masses are of great size, and stand like pigmy crags in front of the greater precipice. The grits of the carboniferous system accumulated on a ledge of mica schist, rise so high as to reduce the outcrop of the chalk to little more than a line of flints, as has been before observed; and the chalk is lost between this point and Slieve Gallion.

No. 16.



The chalk of Slieve Gallion Cairn is upwards of 20 feet thick, graduating downwards into the indurated greensand. Above it the usual phenomena of contact are visible: silicified chalk, calcined flints, and unctuous clay, 3—4 feet thick, mixed with flints. Below the cretaceous rocks is the new red sandstone (Pl. E. fig. 3.); and in advance of this elevated portion is another low chalk escarpment extending from Magherafelt, by Moneymore and Coagh, into the County of Tyrone; it corresponds to the patch in Errigal, rests like it on the new red sandstone, and is surmounted by basalt. Though it is highly probable that the chalk of Slieve Gallion has in some degree been raised to its present elevation by an uplifting force, it must be remembered that it corresponds in position to the high western chalk range of Benbradagh, &c.; and as the difference in position (Pl. E. fig. 3.) between the high and low portions is not more than would produce a very moderate dip of the strata, it may be inferred that denudation has here taken place to a very great extent, laying bare the subjacent strata (see the Section, fig. 3). The increasing dip of the strata on receding from the lower chalk escarpment towards the metamorphic and syenitic region, indicates a considerable amount of pressure on the lower beds of the new red, in the interval between the two portions of chalk. There is here no guide to the bottom line of the new red.

On the road from Magherafelt to Moneymore, near Gortagilly School-house, there is a remarkable indentation in the line of chalk, accompanied by some disturbance, as is shown by the increased dip of the strata; farther on there is a slight break and depression of the chalk; but nothing very curious appears till we arrive at the quarry of Tamlaght near Coagh—(See Pl. C. fig. 1.) At this remarkable place the appearances are extremely striking and beautiful. A trap dike of considerable size, 35 feet wide, cuts through the chalk, the strata of which are on one (the eastern) side curved downwards to it; and at a short distance from the dike there is a fracture filled with rubble of flints and decomposed trap, facts which taken together, seem to imply a great heaving force bending the chalk before it gave way, and permitted the melted matter to fill the new-formed gap. The dike itself is formed of large, rude, and inclined columns, and the phenomena of alteration are reciprocal; the trap cavities containing calcareous spar, and the surfaces of its fractures being coated by the same mineral, whilst the chalk is so far silicified as to be nearly useless. In the centre, the dike is fine-grained and crystalline, on its sides it is decomposed and soft, disintegrating rapidly on exposure; and a most interesting mineral substance, one evidently the result of chemical change, rests in nearly perpendicular beds against the dike and between it and the chalk (left uncoloured on the sketch). It looks like clay, is of a light slate-colour, moist and soft when taken up, but drying on exposure, into thin flakes, nearly parallel to the surfaces of the dike. It has been analyzed by Dr. Apjohn, and found to consist of—

Silex	52·42	
Alumina	7·52	
Magnesia	7·13	
Prot. ox. Iron	3·70	
Lime	0·34	
Water	28·86	
		99·97
Loss		00·03

Dr. Apjohn observes,—

"I do not know that we would be justified in considering it a definite compound, but assuming it to be such, I find its constitution will be very accurately represented by the following formula: MO—representing the isomorphous bases, magnesia, lime, and prot. ox. of iron—

$$3\ Al_2\,O_3,\ 4\ Si\ O_3 + 9\ (MO,\ 2\ Si\ O_3\ ) + 62\ HO.$$

"This substance appears to have some analogy, as respects its composition, to meerschaum or magnesite."—(Vide Thompson, pages 177—9.)

If the variations in the elementary proportions of the several substances. classed by Dr. Thompson as meerschaum, magnesite, &c., be considered, it is indeed probable that many of them have, like this, been produced under circumstances tending to effect new chemical combinations of the constituents of mineral masses in contact with each other. The practical application of this substance has not as yet been tried; but the analogy to meerschaum should not be overlooked.

It is deserving of notice that the magnesian clay following the course of the dike downwards served as a dam to retain the water pent up behind it; when cut through, a neighbouring well was suddenly dried up, and a pump at Spring Bank House also became dry. The lower portion of the chalk is here a very curious pebbly or conglomeritic bed, with much green matter, but still containing many fossils of the lower chalk or grey marl, such as Ammonites *Lewesiensis, Nautilus elegans* (var.), *N. radiatus* of D'Orbigny, *Baculites Faujasii, Hamites, Inoceramus Cripsii, Cardium decussatum,* &c., &c. Its total thickness is about 30 feet, and it rests on the variegated shales or marls of the new red sandstone. The new red passes into Artrea parish, and is still occasionally accompanied by the basalt now much broken up. The chalk also appears again, about a mile from Stewartstown, and half a mile from the carboniferous limestone which separates it from another portion of the chalk half a mile west of the town; this separation appears due to denudation which has exposed the edges of the underlying strata. The basalt is still seen pursuing its course through Clonoe parish, towards Lough Neagh; and in the very heart of the coal district, in the townland of Lisnastrane, a minute patch of chalk (now visible only in the rubble of an excavation,) attests the former continuance thus far of the deposit, which, or the subjacent new red, must have there rested on the coal strata. The large lumps of trap, near Killyman, may possibly have been a portion of basalt still farther continued, but the locality is an obscure one. In respect to the thickness of the chalk, it may be observed that it nowhere, within the western portion of the basin, equals the amount ascribed to it—even at the White Rocks falling short of 100 feet. The flints are arranged in lines from 2 to 3 feet apart—sometimes separated—sometimes nearly run together; and it is remarkable that the fossils are in some places more abundant in the chalk—in others in the flints.

The chalk formation has thus been traced in its northern and western limits, affording throughout evidences of the most striking results of its near approach to or contact with the great overlying mass of basalt. The general condition of the chalk, its hardened texture and its splintery structure, is one of change; but this has probably been effected by causes acting from below, as it is often as remarkable at the bottom as at the top; and even now the hardness is not so great as from the smooth and splintery fracture might be supposed, slices of it cut for the microscope bearing grinding with difficulty. The phenomena exhibited on the upper surface, are those of chemical change, and mechanical action combined; the chalk becomes sometimes vesicular and crystalline, and more generally siliceous; the flints are shattered, and accumulated in beds mixed with very little calcareous matter; they are often red, sometimes a dull white, and so shattered that they crumble into little angular fragments; sometimes again they have been fractured and re-united. The basalt rarely rests directly on the chalk; but is separated from it by clays, and flinty ochreous conglomerates, which appear to indicate a deposit of volcanic mud, prior to any more decided basaltic flow; and even when these intermediate deposits are at a minimum, the lower surface of the basalt is much altered, being close-grained or earthy in texture, and breaking into small cubical fragments; all of which are facts of great interest. The greasy earth or clay, found between the chalk and basalt has been analyzed for this report by Dr. Apjohn, and may be compared with Dr. Kennedy's analysis of basalt, quoted by Dr. Thompson, Vol. 2, page 212:—

CLAY.	
Silex	50·75
Alumina	20·87
Per. ox. Iron	15·90
Lime	0·72
Water	10·50
	98·74
Loss	1·26

BASALT.	
Silica	48
Alumina	16
Lime	9
Soda	4
Prot. ox. Iron	16
Muriatic Acid	1
Water	5
	99

Between these, as regards the silica, alumina, and iron, there is considerable analogy; but the lime and soda are nearly or entirely wanting in the clay. If the clay be considered a modified form of basalt, its condition may have been one of the results of contact; but it is at least equally probable that this clay was poured out prior to the flow of basalt. The chemical condition of the flints is only slightly changed: they are sometimes dull white, compact and opaque, and scratched by the knife, in short, approaching closely to the appearance of some of the harder chalk. One of these Dr. Apjohn has also analyzed, and found to contain—

Silex	94·01	
Alumina & Per. ox. Iron	1·34	
Lime	0·56	
Water	3·09	
		99·00
Loss		1·00

a considerable quantity of water entering into its composition, but without any other material change: it has a considerable analogy in its proportions of silica and water, to opal; the lime may be accidental, as it often occurs within the flints.

The lias being limited in the district which has been described, not extending many hundred yards beyond the locality of Lisnagrib, where the supposed triasic strata appear, and possessing so much interest from its connexion with Portrush, it seems desirable to inquire to what extent the fossils of so stunted a deposit assimilate with those of more highly favored liasic localities. The following list, therefore, has been drawn up for the purpose, including some of the fossils of the lower greensand:—

PENTACRINITES *basaltiformis*—Magilligan, *Larne;* marl.

DENTALIUM *tenue* (Portk.)—Aghanloo, *Ballymaglin* and *Ballycarton*.—Fragments of this delicate dentalium occur, with Modiola minima, in a fine calcareous grit; the longest ·4 of an inch, is about ·04 of an inch in diameter at the largest end, and tapers to a fine point. It is very slightly curved. Magilligan, *Craig* and *Gortmore;* hard calcareous grit.

PHOLADOMYA *ventricosa* (Goldfuss)—*Ballintoy;* calcareous clay.—None of the specimens being perfect, there is some difficulty in identifying them, more particularly as there seems to be a considerable range of variation. Goldfuss' description is: " testa deltoidea ventricosa concentrice striata, antice cordato-truncata carinata postice angustata, umbonibus anticis terminalibus gracilibus, costis (5) verticalibus secunda carinam efformante;" he adds, " as high as long;" in our specimens the height is rather more than the length, the thickness is " only a little less;" the first rib bounds the heart-shaped flattening of the front, and the second forms a keel, most marked at the beaks. Respecting the three other ribs, it is possible that the number is occasionally greater; the beaks are narrowed and elegant, the concentric striæ appear to have slightly granulated the ribs. The young of this species occurs at Portrush.

PHOLADOMYA *longirostris*, Cardium longirostre (Schlotheim)—*Ballintoy* marls.—Of this species, two specimens only have been found, the one young, 1½ inches high, and exactly resembling the figure given by Pusch from a cast, the other 3¼ inches high. It is remarkably flattened from front to rear, so that the length is in the small specimen not much more than a third of the height; and in the large, though partly crushed, it could not have been much more: the thickness is about two-thirds of the height. The ribs in front are not very distinct; there appears, however, to have been one bounding a heart-shaped space, and posteriorly, five or six. The beaks are very elevated and elegant.

PHOLADOMYA—Height 1¼, length 2 inches, thickness 1 inch. Beaks large and swollen, concentrically striated; no ribs. This resembles Myacites ventricosus, of Goldfuss and Schlotheim.

PANOPÆA ? *elongata* (Roemer)—Pl. xxxiv., fig. 19.—*Ballintoy* calcareous clay or marl, Aghanloo, *Ballymaglin; Portrush Rock.*—Elongated, oval, convex, concentrically wrinkled, anteriorly short, narrowed, and rounded, posteriorly produced, dilated, depressed, with an oblique rounded angle (or oblique sub-truncation), cardinal margin, straight, posteriorly, sub-ascending beaks, small, incurved, slightly projecting. Roemer adds, that the line proceeding obliquely from the beak to the posterior margin, almost forms a keel. Though the actual genus described by Roemer, from casts, may be doubtful, there can be little doubt of the identity of our fossils and his. In the Portrush specimens they are seen looking down on the hinge, and, if actually closed, do certainly gape at the extremities. This is one of the few fossils which occur in the lias marl of Ballintoy, in the lias limestone of Aghanloo, and in the Portrush Rock. The expanded posterior margin distinguishes the internal casts of this species from those of U. concinnus. Roemer's locality is belemnite beds of the lias, near Willershausen. I am inclined to doubt that this is a Panopæa, from the deep impressions on the cast.*

LYSIANASSA *rhombifera* (Goldfuss)—Lias—Antrim, *Ballintoy, White Park;* dark grey, calcareous clay, or blueish-grey marl. The V shaped ridges in the line of the beak, are cut off by short transverse lines; the lateral ridges do not converge, but are directed more outwards, associated with fragment of Belemnites acutus, Arca ? pulchra, &c.

CORBIS ? *ovalis* (Phillips)—*Ballintoy.*

ASTARTE—Aghanloo, *Ballymaglin.*—Grey, gritty, and sparry limestone, not strictly determinate, though resembling Phillips' A. elegans, which appears more strongly marked, as to lamellæ, than Sowerby's.

ASTARTE *tetragona* (Morris *Mss.*) *Ballintoy.*—Not rare in Bristol lias, (Stutchbury).

Indeterminate Pallustra, Magilligan, *Craig* and *Gortmore;* highly calcareous grit, weathering ferruginous.

CARDIUM *truncatum* (Sow.)—Aghanloo, *Tircorran;* whitish, highly calcareous, gritty marl, hard and splintery. The scabious character of the ribs not perceptible in these specimens, which have lost the shell. This species, as it increases in size, differs considerably in form, as it becomes proportionably more flattened and expanded. Larne—shale, or micaceous indurated clay, not like coal shales, but grey. Here the scabious character of the ribs is perceptible, the shells are larger, more expanded, and, in consequence, less gibbous than in preceding locality. Magilligan, *Craig* and *Gortmore;* very young individual, also in hard calcareous grit, see Sowerby's remark of localities, "ferruginous sandstone."

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* The figure should be more attenuated in front.

CARDIUM *striatulum* (Sow.)—Aghanloo, *Lisnagrib* and *Stradreagh;* dark laminar shale. The smaller shells appear doubtful, and may be a flattened variety of C. truncatum.

CUCULLÆA *cucullata?* (Munster and Goldfuss)—*White Park, Ballintoy.*—Goldfuss gives this as from the under oolite. This species cannot be very decidedly identified from the specimens; it has considerable resemblance, in general form, to Arca pulchra of Sowerby; but in that species there are no concentric striæ, and the radiating striæ are stronger than in this. The radiating striæ are very fine, not generally visible without a magnifier, in one specimen rather stronger in front, but without any appearance of ribs; transverse striæ also fine, though stronger than the radiating. The shell is rounded in front, and obliquely truncated behind—bluntly keeled from the beak to the posterior angle.

NUCULA *rostralis* (Goldfuss)—Magilligan, *Craig* and *Gortmore.*—Hard calcareous grit; no striæ visible on these casts, the shell not being preserved.

NUCULA *variabilis*—(Sow.)
——— *subglobosa* (Roemer) } Magilligan—*Craig* and *Gortmore.* The concentric striæ of M. Roemer's species are not visible in these rough-material casts, but they possess the general form, trigonal, ventricose, posteriorly rounded. M. Roemer mentions the resemblance of his species to N. variabilis, which, however, he observes, is somewhat smaller, and in front more oblique, and less perpendicularly truncated, posteriorly more diminished, and throughout less arched. In size, many of the specimens in these hardened calcareous grits, agree well with Sowerby's smallest specimen, but in form they are then more like Roemer's species. Others again, if the same species, are more transverse, as in Sowerby's larger figure; it seems, therefore, a link between the two species. A form also occurs more triangular, and strongly resembling Sowerby's N. antiquata.

PACHYODON *concinnus* (Stutchbury)
UNIO *concinnus* (Sowerby) } Aghanloo, *Ballymaglin;* crystalline limestone. One young specimen, probably the only true one we have.

PACHYODON *crassiusculus* (Stutchbury)
UNIO *crassiusculus* (Sow.) } *Tickmacrevan, Glenarm;* calcareous clay or marl; probably also Portrush. Stutchbury considers his species and that of Sowerby identical, and believes that the locality given by Sowerby is an error.

Pachyodon (Unio) *ovalis* (var. rugosus, Stutchbury,) *Larne;* calcareous clay.

Pachyodon } Magilligan and Aghanloo—grey calcareous rock, with
Unio } crystalline fragments, or indurated marl; same rock and same shell, though larger, at Larne—This shell has a sub-trigonal form, but is rounded both anteriorly and posteriorly, the margin rounding off gradually towards both ends. Distance in front of the beak to that behind, as 1 to 2·5; but varying with age and other modifying circumstances; height to length, 1·1 to 1·9. Besides the lines of growth there are strong concentric striæ, similar to those on pallustra. By age the shell becomes flatter and more rounded, and in one example the remains of the shell is curiously perforated by some minute borer. It has some analogy to N. peregrinus Phill, and approximates to Unio Nilssoni, of Koch and Dunker, which, however, is less rounded and more trigonal.

Unio *Listeri*, Portrush. Though compressed and distorted, I believe the specimens must be referred to this species, or to U. crassiusculus. Ballymaglin, Magilligan—marls.

Unio *trigonus*? (Roemer) } Antrim—*Tickmacrevan, Glenarm,*
—— *hybridus*? }
marl.—This shell is attenuated posteriorly, and, from the flat curve of the posterior side to the back, becomes trigonal in appearance. The beak is small and sharp, the lines of growth are distant and strongly marked; but on this specimen—the only one of exactly the same character—there are no intermediate striæ; such, however, are seen on the preceding specimen of U. Listeri, so that it is probable that their presence or absence depends on the condition of the surface. The form of this shell is certainly very different from the normal form of U. Listeri, and it is flatter; yet it may be doubted whether it is beyond the limits of its variations. It is distinguished from U. hybridus by the difference of its proportions, the length being to the breadth nearly as 3 to 4, a proportion agreeing exactly with Koch and Dunker's figure. It may be added, that the latter authors represent the beak blunted, and describe it as obsolete; this must, however, be accidental from wear, as it does not agree with Roemer's description, "acutinsculus" "ziembich spitz," tolerably sharp; in other respects their figure is better than Roemer's.

Unio *Nilssoni*? (Koch and Dunker) var.—*Ballintoy, White Park;* calcareous clay.—Transverse, ovate, sub-trigonal, in front short and rounded, posteriorly produced and gradually diminished, marked concentrically by strong lines of growth and by intermediate striæ. Beaks sub-turned and obsolete. The proportions given by Koch and Dunker, breadth 100, length 58, thickness 40, agree very well with those of our specimens; but the hinge line is not so straight as in Koch's figure. Foreign locality—lias marl and lias schist, at Exten, near Rinteln.

PACHYODON *hybridus*, var., and PACHYODON *imbricatus*, are both considered by Mr. Stutchbury as represented by our fossils.

MODIOLA *minima*? (Sow.) Aghanloo, *Ballymaglin* and *Ballycarton*. —fine calcareous grit, full of minute organic bodies. See also Roemer. Sowerby's locality for this species is rather uncertain. "This occurs in a grey argillaceous limestone—the largest was sent me from Taunton by my friend R. Hare, Esq. One of the small ones was found near Belfast, by Dr. M'Donnell, along with Gryphites." Tab. ccx. Figs. 5, 6, 7. Roemer's locality is "The upper lias marl of Adenberg, near Goslar; often in great numbers." It is also here in profusion on the face of a thin layer of calcareous grit, which is filled with minute organic bodies, including more than one species of almost microscopic turreted shells, fragments of spines, and also of a delicate dentalium.

MODIOLA *oblonga* (Roemer)—Magilligan, *Craig* and *Gortmore;* very hard calcareous grit. The anterior portion of this shell does not become narrower, as is usual with the genus; it hence obtains an oblong form, unlike the usual shape of modiola, and merging into that of avicula. Roemer thus characterizes it—"Oblong, swollen, concentrically sulcate, striate, but not plaited on the back, beaks thick and incurved. From the Portland rock, near Hildesheim, but rare." Our specimen, in the hard calcareous grit, so strongly resembles this species, that at least it may be considered a variety of it; but two other specimens (if the same) show that this shell attained a large size, and became gibbous with a very expanded wing; the latter from Ballintoy.

MODIOLA *bi-partita*? (Sow.)—Magilligan, *Craig* and *Gortmore;* hard calcareous grit. Small specimens occur of this species, well distinguished by the strong depression between the lobes. Some of the shelly matter remains on these specimens.

MODIOLA *Hillana* (Sow.)—Antrim, *Tickmacrevan;* very hard splintery grey limestone.—This specimen is much elongated, pyritous, and quite smooth in the upper part, but towards the front the fine concentric striæ or raised lines are visible; the shell is attenuated to the front, but the beak is not quite terminal. White Park, Ballintoy, also, hard grey impure limestone as before.

MODIOLA, associated with pecten subulatus, avicula, &c., probably M. compressus, Goldfuss.

MODIOLA *scalprum*. There appears to be a great range of variation in this species, or else several species have been confounded together. Phillips' figure represents it strongly curved; Sowerby considerably less so; Goldfuss still less; and finally, the species I ascribe to it, so much less as in some specimens to become nearly straight.

I should have doubted whether this might not have rather belonged to M. sub-æquiplicata, Strombeck, as described and figured by Roemer, but Goldfuss' description and figure of a species with similar name, do not correspond with those of Roemer, and I am almost inclined to think, that M. sub-æquiplicata, Strombeck, is within the range of variation of M. scalprum. The striæ are strong, and the species in that respect approximates to M. plicata, as figured by Sowerby, though not to the deeply plaited variety figured by Goldfuss. Young, Larne; hard grey calcareous rock. Tickmacrevan; hard grey calcareous rock; large and very straight. Ballintoy; blueish marl or calcareous clay, large; not quite, though nearly as straight as the Tickmacrevan specimen, and identical with it in all its leading characters; another, rather more bent, but identically the same. Aghanloo, Tircorran, cannot be distinguished in form from Sowerby's figure. In this remarkable chalk-like substance, the striæ are less marked than in the large specimens, less than 2 inches long.

TEREBRATULA *ornithocephala*? (Sow.)—Aghanloo, *Ballymaglin.*—Hard, sparry, grey limestone, crystalline fragments.—In this specimen the plaits entirely disappear; in another, from Ballintoy, nearly so. They approximate, therefore, to T. subovoides, Munster and Roemer, but have no fine longitudinal striæ, at least none perceptible.

TEREBRATULA *obovata*, Ballintoy.

TEREBRATULA, Magilligan, *Duncrum.*—A pretty plicated species, ·4 of an inch long, having about 16 folds or sharp ribs, of which four in the centre (one of which is sometimes furcated, so as to make five,) are raised. The upper, or perforated valve, is flatter than the ventral, transverse striæ are perceptible by the magnifier; not identical with any described species, though resembling T. Mantelliana of Sowerby.

LINGULA *Beanii*? (*Craig* and *Gortmore*); hardened calcareous grit.

MELANIA.—Aghanloo, *Ballymaglin;* gritty limestone or calcareous grit.—Fragment 1¼ inches long. Not specifically determinable, but from its nearly flat sides, approximates to M. Bronnii of Roemer; it is, however, less cylindrical than that species.

TROCHUS *anglicus* (Sow.)—*Ballintoy, Larne Lough.*—Cast of Trochus more bulky than the cast of T. anglicus; is probably a cast of T. faniatus.

TURRITELLA (Cerithium) *percincta* (Portk.)—*Craig* and *Gortmore;* hardened calcareous grit; closely allied to T. cingeuda, as given by Phillips, though it would appear doubtful whether that is identical with Sowerby's. Very minute, 8 volutions in ·25 of an inch. Whorls more convex than in Sowerby's figures. Of the spiral raised lines, one along the centre of the whorl is more elevated than the others, and another below it nearly as much so—a finer line being between them; which produces the appearance of a band. Above the stronger line there are three or four finer, though still well marked lines; and below it also three or four, including the second stronger line. This is distinguished from T. minuta of Koch and Dunker by the greater number and inequality of size of the spiral threads. Associated with Lingula Beanii.

TURRITELLA (Cerithium) *tenui-costata* (Portk.)—Antrim, *White Park, Ballintoy;* highly calcareous marl here indurated to a limestone; associated with Amm. intermedius. This minute shell is allied to several described by Sowerby, Roemer, and others, but is yet clearly distinguished from them. Whorls convex; spiral threads of two sizes; three strong on the lower half of the whorl, and one fine below them. On the upper half there are four or five fine threads, which are very close together; whilst the strong threads of the lower half are separated by a considerable space. The fine threads are in like manner separated from the strong by a space equal to the separating space of these lines. All these spiral threads are crenulated by numerous very fine-curved longitudinal threads, of which there must be more than 30 on a whorl. Very minute, 6 whorls in ·25 of an inch.

CERITHIUM *carbonarium*? (Goldfuss)—Aghanloo, *Ballymaglin* and *Ballycarton;* very hard calcareous grit. These very minute shells are difficult of identification in so hard and coarse a material; but the aperture appears to be that of a cerithium. The longitudinal ribs are visible, but the spiral striæ are not.

PINNA *Hartmanni* (Ziethen and Goldfuss)—Magilligan, Boundary of *Tircreven* and *Lower Ballyleighery;* calcareous grit.—*Larne,* in earthy and sparry grey limestone, similar to that containing Amm. Sampsoni. Cuneate—"in front quadrangular, behind flat convex. From the beak radiate small distant ribs, which, through concentric striæ and lines of growth, are broken and displaced from their direction. These ribs are on the front half very regular, but behind are irregular." Goldfuss cites as a possible synonym, Pinna granulata of Sowerby, apparently from the fragment of the shell shown on Sowerby's figure; the decussation, however, of the ribs in that figure appears to be too regular for this species. Many of the specimens now under consideration are divested of the external shell, and are then identical in form with Goldfuss, fig. 36, Pl. cxxvii.—the longitudinal ridge and suture being strongly marked. The section for a considerable distance from the beak is distinctly quadrangular—the diagonals being as 2 to 3 nearly externally, and this flattens down towards the front, where the shell becomes also considerably expanded. The shell is very thick and fibrous, and peels off in several layers—the external surface of all, excepting the outer one, being smooth: hence it is only where that truly outer surface is preserved that the existence of ribs can be determined. On one specimen this is partly the case. The ribs are very fine, and decussated by undulating striæ and by concentric waves. The ribs do not appear to extend to the front, but they may have been obliterated: hence would not produce so coarse a decussation as that of the front of Goldfuss' figure. In general form, then, this shell agrees with P. Hartmanni, though perhaps it differs sufficiently to be separated as a variety. In one imperfect specimen the ribs are more extended longitudinally, are stronger and more roughly decussated—looking, in this respect, much like P. granulata; Ballintoy; impure calcareous bed approaching to a limestone—Goldfuss' locality is lias limestone of Vahingen, and lias sandstone of Göppingen. Sowerby's locality for P. granulata Kimmeridge clay of Weymouth—another reason as well as the breadth of that shell, and the want of a distinctly angular ridge for believing that it is not synonymous with Zicthen and Goldfuss' species. A large specimen, exhibiting the inside with fibrous coat, is 8½ inches long.

PINNA *cuneata*? (Phillips: Bath oolite)—Magilligan, *Tircreven, Lower Ballyleighery;* calcareous grit.—This species, which is flattened in front, is distinguished by the transverse striæ, forming obsolete flat transverse ridges—being on one side of the mesial ridge straight, and on the other only curved near the mid rib. Phillips' figure gives the idea of curvature in the shell itself; but our specimen, also a fragment, 3 inches long—seems quite straight. The fibrous coat is formed of more than one layer.

PINNA *lanceolata*—Magilligan, *Lower Ballyleighery;* calcareous grit; *Ballintoy* marls.—The section is more quadrate in this species—the faces on each side of the mid rib being equal, or nearly so, and the section is therefore, externally, almost a regular rhomb; internally, it is rounded. It does not flatten either towards the front in the same degree, but retains the rhombic section. The shell, of which a few fragments are preserved, is brown; ·1 of an inch thick, but not fibrous: hence, if a fibrous coat were additional to this, the whole thickness would be considerable. No marking fully preserved, though traces of transverse lines can be observed. The central lines of the cast are quite rounded; (see Goldfuss.)

ANTRIM, *Ardclinis*—hard grey calcareous rock, one specimen strongly resembling Phillips'—Pinna mitis; there are, however, fine concentric threads besides the stronger undulations represented by him, though they are only seen distinctly near the beak, and become irregular towards the front; there are no longitudinal lines, and the shell in front is wider and more flattened. It is very doubtful whether these shells should be considered Pinnæ; it is more probable that they are Inocerami, length, 1½ inch; beak short and slightly bent.

AVICULA *contorta* (Portk. Pl. xxv. fig. 16.)—Boundary of Magilligan and Aghanloo, Boundary of *Lisnagrib* and *Stradreagh, Larne ;* shale, not effervescing.—Shell convex, or produced at the beak, highly arched over the hinge line; twisted or curved backwards towards the posterior, or elongated portion of the hinge line, which it thus approaches at the margin. Ribs fine and numerous, generally alternating larger and smaller. The opposite valve is probably very much flatter, though no satisfactory specimen of it is preserved. Allowing for contortion from pressure in this shale, the universality of the direction of twist in all similar valves shows that some portion of this form is original. Something of the same kind, but in a less degree, is seen in Phillips' Avicula expansa, and in Munster's Avicula arcuata—Goldfuss, Pl. 117, fig. 1. This latter species indeed strongly resembles ours in form, but it has concentric striæ, and no radiating ribs.

AVICULA *inæquivalvis—Portrush Rock.*—The striæ between the strong and distant ribs are faintly perceptible on this cast.

AVICULA *modiolaris* ?—Resembling in the small front and general form A. Goldfussii, of Koch and Dunker ; but in this the angle of the axis, with the hinge line, is only 45°, instead of 60°, as in that species.

AVICULA ———,—Calcareous grits—*Tircreven Burn*, a small species, with very slight elongations of the hinge, as in A. sub-striata, Bronn ; but having no visible striæ.

INOCERAMUS *Hamiltonii* (Portk.)—Antrim, *Carncastle ;* calcareous grit.—It appears probable that, notwithstanding the numerous species which have been formed in this genus, there is still some confusion in their determination ; for example, the figure of I. latus, given by Goldfuss, does not exhibit, by any means, a rhomboidal form, so marked as in Sowerby's. Goldfuss' species ranges down to the greensand ; that of Sowerby is from the upper chalk. The species here under consideration does not agree precisely with any of those described. It is plano-convex ; but though moderately flat towards the margin, it becomes tolerably elevated at the beaks, which are distinctly raised and moderately sharp. It is nearly equilateral, generally rounded, and nearly equivalved. There are irregular concentric waves, and strong raised concentric striæ or lines. The exact form of the hinge line cannot be determined from the specimens. It is apparently a small species, unless all the three specimens in our collection be considered young. The length of the best is only 2¼ inches, and breadth nearly the same. Two specimens from Sallagh Braes have the waves strongly marked, are nearly circular, and one is more lengthened. This latter would, in form, resemble Goldfuss' figure of I. planus ; but in that species the beaks are flat. Provisionally at least it seems necessary to consider this a distinct species, until the amount of variation of form due to age is better understood. It is a greensand fossil.

INOCERAMUS *cinctus*? (Goldfuss)—Antrim, *Larne*. Gritty indurated grey marl or impure limestone, slightly adhesive to the tongue.—This remarkable shell is described as depressed, oval, acute, the beak nearly in the axis. Hinge line very short; sides rounded. The fibrous shell is not preserved in the specimen referred to this species, but merely a very thin external layer, in which are visible the fine thread-like concentric striæ. Length 1½ inch, much flattened, and hence expanded towards the margin.

GERVILLIA—Antrim, *Carncastle*.—Very calcareous loose grit, slightly adhesive to the tongue, strongly resembles the whitish grits of the new red; but this is full of the little greensand particles.—Though nearly allied to Gervillia angusta of Goldfuss, they do not appear identical. In this, so far as the imperfection of the specimen will admit of judging, the valves are neither so narrow nor so deep as in Goldfuss'; hence the section furnished by the closed valves is not, as in that species, triangular, but flat. The valves, too, are wider opposite the hinge line; but the curvature and elongation backwards are equally remarkable in this as in that species.

PECTEN *Valoniensis* (Pl. xxv. fig. 14, 15)—Aghanloo, *Tircorran*, very loose gritty marl, much like the beds in new red sandstone; opposite side of specimen, one of the contorted aviculæ. Also Larne in shale, not effervescing.—In this shell the ribs are numerous, rounded in the cast, except towards the margin, where they appear sharp, and are much smaller and rather irregular, small being occasionally mixed with large on no definite plan. The ears are tolerably large, and nearly equal; the larger or front ear is radiated by small, but distinct, ribs, which are crossed by closely set thread-like striæ; and in the same manner a portion both of the anterior and posterior margin is similarly striated in a direction oblique to the ribs: this must have rendered the shell a very pretty object. Fine lines of growth are also visible round the base.

I am induced to consider this shell the Pecten valoniensis (Defr.), both by the figure given in Memoires de la Sociétié Géologique de France (Tome 3, Pl. 24, fig. 6), and by the remarks upon it by M. Alexandre Leymerie. "Ribs disposed in such a manner that smaller are interposed more or less irregularly between the great, a character, however, not very constant. Very fine transverse striæ are also observed, and the ears are charged with fine vertical striæ." In our specimens the striæ are transverse or horizontal on one ear, and vertical on the other, gradually becoming oblique so as to blend in with those of the lateral margin; and traces of the latter may also be discovered in M. Leymerie's figure.

PECTEN *sublævis* (Phillips, Young, and Bird)—*Portrush Rock*—This shell has the general characters of Pecten æquivalvis (Sowerby), the ribs being about 20, and the spaces between them wider than the ribs themselves; it is, however, comparatively small, 1 to 1½ inches in length, and has few or no concentric striæ. In the hardened casts none are visible.

PECTEN *vimineus*—*Portrush Rock.*—Small individual.—The form of the ears, ribs, &c., render it probable that these are casts of small individuals of this species, (see Bronn's figure of such a cast, Taf. xix. fig. 3 a,) the ribs appearing smooth on such casts. The ribs do not alternate with smaller ribs, in which respect the species differs from P. textorius, and some other species having a similar form of ears; the left small, being a continuation, with very little slight bend, of the ordinary lateral margin; right ear prominent, and twisted at its junction with the side.

PECTEN *textorius* (Schlotheim and Goldfuss) }
PECTEN *virguliferus* ? (Phillips) } calcareous clay,
Ballintoy.—Numerous rounded, elevated, but not large ribs, either equal, or, which is generally the case, having smaller interposed between the larger, rendered scaly by numerous concentric striæ. Ears are imperfect in the only specimen, a sinistral valve, but show inequality, and the existence of some scaly striæ on the larger ear. This differs from P. vimineus, in having smaller and more numerous ribs. It has also considerable resemblance to P. elongatus, a tertiary fossil.

PECTEN *subulatus* ? (Munster and Goldfuss) }
PECTEN *sublævis* ? (Roemer) } Antrim, *Larne;*
gritty indurated grey marl or impure limestone, slightly adhesive to the tongue; associated with Ostrea.—Small specimen, ·5 of an inch long, "obliquely oval, inequilateral, plano-convex, smooth; front ear elongated; posterior ear very short:" to this is added, by Goldfuss, that a magnifier discovers very fine crowded concentric striæ, and some radiating lines. The surface of the imperfect specimen under consideration is white and powdery, and not sufficiently preserved to show the striæ. The difference of the length of the ears and the general form lead to its classification with this species—lias-kalk of Altdorf, Amberg, &c.—*Ballintoy*—calcareous clay.—This specimen has the orbicular form, is a cast and smooth; but by a magnifier very fine radiating lines are discernible, concentric lines not visible. There seems to be very little difference between these species; the ear is not quite perfect in our specimen, but it would seem to agree best with Roemer's sublævis. Magilligan; *Duncrum,* in limestone.

PECTEN *calvus* (Goldfuss)—*White Park, Ballintoy;* shale, not calcareous.—Larger specimen, ·6 of an inch long; a cast and impression.

On the ears of the impression, and partially on the other parts, the very fine concentric striæ can be traced. Ears unequal; square. Also, Portrush? very small specimen.

Pecten *textilis*? (Munster and Goldfuss)—*Larne;* hard calcareous grey rock.—Large ear of Goldfuss' specimen, finely radiating lines, and very fine concentric cancellating striæ; associated with A. intermedius.—Magilligan, *Aghanloo;* hard calcareous rock or impure grey limestone, associated with the large Oyster and a Pecten, probably Pecten subulatus, ·7 inch long.

Pecten, Cast.—Upper valve very flat convex; right ear moderately large; left destroyed; length 1 inch; breadth the same; remarkable triangular form, the sides extending straight to the greatest breadth, and the front being then rounded off; deeply impressed from the beak, as in P. cingulatus, to which it is allied in form, but differs in ears.

Pecten *quinquecostatus* (Sowerby)—Antrim, *Sallagh Braes.*—This is a cast, and the transverse markings are lost. Substance, calcareous grit, with very minute dark granules, not much affecting the colour, which is dirty white or grey; more resembling the quadersandstone than the greensand.

Pecten *æquicostatus*?
longicollis? (Roemer) } Antrim, *Glencastle;* calcareous grit. Though this shell has the produced character of the beak of Pecten æquicostatus, it does not accord with Goldfuss' description, in which the ribs are stated to be twice as broad as the spaces between them; whereas in our specimens (two only), the breadth of the ribs and of the spaces is about equal. The number also of the ribs is greater, and they are smaller, corresponding in that respect to Roemer's, viz., longicollis, but not in the proportions of length and breadth, which do not differ so much as in Roemer's.

Lima *alternans* (Roemer)—*Portrush Rock, Ballintoy;* calcareous shale or clay; lias marl.—"Shell obliquely oval, truncated in front with from 12 to 16 ribs; the ribs plano-convex, and the spaces between them equal and flat. Found in the lias-marl, on the Langenberg, near Goslar." The ears were imperfect in Roemer's, as they are in our specimen. Though this resembles, in general form, several of the small Limæ, such as L. pectinoides, it is easily distinguishable by the smaller number, form, and arrangement of the costæ. In this specimen fourteen may be counted. On the cast of the inside, these are plano-convex, and the spaces between them flat; and as the ribs and their intervening spaces increase in the same proportion from the beak to the margin, they have ultimately the appearance of being comparatively distant. Little of the shell is preserved, but enough to show that appearances would be somewhat modified by it. The ribs become more convex, and by a magnifier and good light, extremely fine transverse and longitudinal lines may be discovered, though these are so delicate as to require a change of light for each. It is remarkable that, in the foreign as well as the home locality, the containing mineral bed is a lias marl. This is associated with one of the arcacea, very close to Arca pulchra, (Sowerby).

LIMA *pectinoides* (Sow.)—*Portrush Rock.*—Shows no transverse striæ. Ballintoy. highly calcareous clay; not L. *pectinoides*, (Goldfuss) as Sowerby's description, " between each of the ribs the space is very narrow, a little elevated, and terminated at the margin by a tooth," cannot be made to mean a space wide enough to contain two and even three intermediate ribs, Goldfuss' L. duplicata more resembles L. pectinoides, and his L. pectinoides must be a different and new species.

LIMA *rustica* ? (var. figured by Phillips)—*Portrush Rock.*—Rather longer than the greatest breadth ; posterior ear rather large, blending with the side. It would appear from that figure, as well as from the specimen under examination, that the ribs are more thread-like than in Sowerby's upper figure, though similar to those of his lower figure ; thus approaching on one side to Lima rigida. The ribs are much bent, and the spaces between them fully twice the breadth of the rib. It appears to be an intermediate species between Lima rigida and Lima rustica : a cast in which no other points of character can be observed.

LIMA *antiquata* (Sowerby) } Magilligan, *Bally-*
not L. *antiquata* (Munster and Goldfuss) } *leighery.*
Limestone, sparry in patches, a fragment only.—Bronn states that, according to Goldfuss, this is only a smaller form of Plagiostoma Hermanni of Voltz. Goldfuss, however, in his " Petrefacta," does not cite as a synonym L. antiquata, and the descriptions of the two seem severally very distinct. In Lima antiquata the striæ are close ; in L. Hermanni they are separated by considerable spaces. One specimen shows greater irregularity in the ribs, which, however, are close together, and the margin has somewhat of the plaited appearance of L. Hermanni.

LIMA *Hermanni* (Goldfuss)—*White Park, Ballintoy;* hard sparry grey calcareous rock. Also boundary of Magilligan and Aghanloo, sheet 5 ; length 3 inches.—This is a characteristic specimen, the ribs being strong and occasionally unequal ; the spaces between them sometimes equal to, and sometimes much exceeding, their breadth, and the fine longitudinal lines in the spaces well marked. Rocks identical.

LIMA *proboscidea* ? (Sowerby)—Antrim, *Larne, Dunseverick Mill Dam ;* highly indurated clay, or impure grey limestone, associated with Amm. intermedius.—It would appear that this species exhibits considerable variation, the ears being more or less expanded, and the ribs rendered more or less sugged by the tubular processes upon them.—

(See for example Goldfuss' and Sowerby's figures). The ribs of the specimens here referred to this species are rather more slender than in Sowerby's figure, and the tubular processes are adpressed to the ribs. When worn the ribs appear smooth, though the irregular transverse lines are still visible. Neither specimen is perfect, and hence the number of ribs cannot be fixed with certainty; it appears, however, smaller than in Sowerby's; hence, as well as from the smallness of the ears, it is probable that this occupies an intermediate station between L. rudis and L. proboscidea. The largest specimen is 3 inches long.

Lima *duplicata*
Plagiostoma *duplicatum* } Sowerby. *Larne;* highly calcareous clay, crushed cast; here the intermediate rib is quite distinct.

Lima *punctata* (Sow.)—*White Park, Ballintoy;* grey limestone. This is only a small specimen ·7 of an inch long. It is marked by very delicate longitudinal, slightly waved ribs, or flattened raised striæ, which are cancellated by equally fine concentric striæ. The form is that of Lima gigantea; the striæ are not visible without a magnifier.

Lima *gigantea*
Plagiostoma *giganteum* } Magilligan, *Tircreven,* and *Lower Ballyleighery;* gritty marl, approaching to limestone and hard calcareous grit, weathering ferruginous.—Antrim; *South* of *Garron Head;* highly calcareous indurated clay, or impure grey limestone. *Carnlough;* light grey limestone, sparry from crystalline fragments of calcareous spar. *Larne;* highly calcareous marl, as above; distorted by crushing.—*Island Magee;* highly calcareous clay; remarkable for almost total absence of striæ in a young shell; associated with Amm. intermedius.

Plicatula.—Only uncertain specimens.

Ostrea (n.s.?)—Antrim, *Larne;* highly calcareous indurated marl. —This shell is transverse, being wider than long, and rounded at both sides; the lower valve is deep, and attached by a considerable, though varying portion of its surface. The upper is slightly convex. The ribs proceed from a point; not central. Some are subdivided or forked; others not: they are numerous, from 15 to 20; not large, but strong, and obscurely plaited by lines of growth. In the lower valve they generally appear undivided, the point of furcation being within the scar of attachment. In magnitude or strength the ribs are similar to those of O. gregaria, but they have no reference to a mesial plait, nor is the shell oblong, as in that species.

Ostrea *acuminata?* (not plicated), Sowerby—Rounded var., fig. 3, Pl. cxxxv.—*Glenarm, Little Deer Park;* calcareous clay or marl. One specimen of a lower valve strongly resembles Hisinger's Ostrea

Hisingeri in form, though the transverse lamellæ are not sufficiently rugose. As on the same specimen one individual assumes this form, and another approaches the rounded variety of Sowerby's Ostrea acuminata (fig. 3), I am inclined to associate it with that species, doubting, however, the specific identity of figs. 2 and 3. The waves are not quite so large in one specimen; the upper valve is variable, either flat or slightly concave, except at the beak, which is moderately raised.—Magilligan, *Lower Ballyleighery*, Sheet 6. Limestone full of fragments of fossils. This specimen is elongated, sharp at the beak, and there adherent in a small space. It is very deeply waved, an internal cast, and therefore still more resembles Sowerby's fig. 3, though it is still less curved, or rather is straight. It is associated with a Modiola.

GRYPHÆA *incurva*—*Larne*, Magilligan, *Tircreven Burn*, where it occurs abundantly in a bed containing Exogyra lævigata and other greensand fossils, including teeth of Oxyrina.—(See Note at the end of chapter).

GRYPHÆA *Maccullochii*—*Larne*.

GRYPHÆA *Columba*—Lower chalk or upper greensand; *Keady*, &c.,

AMMONITES *Bucklandi* (Sowerby)—Magilligan.—Large fragment in grey, fine grained, smooth, splintery, impure limestone.

A. *Bucklandi* (Junr.)—*Ballintoy White Park;* marl.—Although this shell is in form of section and of ribs the same as the large shell, it may be doubted whether it is actually the same species. Both specimens are very small, less than ·75 in diameter, about two whorls, with strong elevated smooth ribs. Front broader than sides; keel broad and flat, being very little elevated, or nearly obsolete. The septa do not in form correspond with those figured by Bronn, or described by Roemer.

AMMONITES *Conybeari*—*Larne;* highly calcareous clay.—Though fully agreeing with this species in the oblong aperture, in the prominent keel and furrows on each side of it, as well as in the proportions of the whorls and distances of the ribs, there is some little variation in minuter points. The shell appears to have been marked by fine raised striæ, and the ribs are then not so strongly raised, the striæ being parallel to them, and curved forward as in A. striatulus. *Ballintoy, White Park;* bluish grey calcareous clay; ditto, and at the dyke locality, a small variety; seven volutions in 2 inches diameter; the ribs in the inner whorls are strong, though slender; they become comparatively less prominent with age; the keel in these small specimens is not very prominent (in the cast is obsolete), but the furrows are distinct, and the aperture oblong; it has also some resemblance to A. Turneri, but the ribs are not bent forward conspicuously as in that species, nor is this so square in its section.

AMMONITES *multicostatus* (Sowerby)—Magilligan, *Craig* and *Gortmore;* very hard calcareous grit.—None of these specimens attain a large size, but have all the more important characteristics of the species. Depressed, carinated, furrow on the side of the keel, but slight, a modification from age or size. Ribs strong, sharp, numerous, and rise at the front into a knob or tubercle, from which they are bent forwards to the furrow. On one specimen a portion of the shell remains; it was finely striated parallel to the costæ, and renders them less apparent over the front. In whorls about ·4 of an inch wide, the form of the rib corresponds nearly to that of A. rotiformis, the bending extension over the front being nearly obsolete; in those ·8 wide, the bend and extension are quite distinct.

AMMONITES *radians* (Reinecké)—*Carncastle, Ballygalley Head;* highly calcareous bed, approaching to impure grey limestone.—The sigmoidal ribs of this species are distinguished from those of more marked falciferi by the want of an angle or knee, and the general flatness of the curves. It is probable, however, that of the synonyms cited by Bronn and Von Buch, A. striatulus (Sowerby), and A. solaris (Phillips), may in reality be different species. In A. solaris the ribs are represented straight over the sides, and bending forward only at the margin; the section also is much broader in the front, and the keel very prominent. In A. striatulus (Sowerby), the ribs are represented as much less strong and elevated than in Bronn's figure; whilst again Young and Bird represent their A. striatulus as marked "by faint sigmoidal ribs, and slight striæ of the same form." These differences might be ascribed to errors in the figures, or in the descriptions, were it not that they appear supported by specimens. The fragment, for example, which is here named A. radians, is marked by strong elevated sigmoidal ribs, and has the same form of section as in Bronn's figure. It is only a cast, and hence striæ, if they had existed, would not have been discernible.

AMMONITES *striatulus* (Sowerby)—*Ballintoy, White Park;* highly calcareous clay or marl.—In these specimens the shell has been flattened, as remarked by Von Buch of A. radians, "to the thickness of paper." The ribs are very faint, except in the inner whorls, and stronger at the inner than at the outer margin of the whorl. The striæ are very fine, and only slightly sigmoid, being partly modified by the pressure.

Between the strongly ribbed specimen, and those in which the ribs are little more than undulations, there would seem to be too great a difference to admit of specific identity. To one of the latter (a single specimen), I should be inclined to give the name A. nitescens of Young and

Bird, were it not that those authors state the back (front) of that species to be flatter, and the keel less marked ("only a faint appearance") than in A. striatulus. I am obliged, therefore, to consider it a distinct species, and I dedicate it to Dr. MacDonnell of Belfast, one of the oldest and most respected of Irish Geologists.

AMMONITES *Macdonnellii* (Portk.)—(Pl. xxix A. fig. 12.)—*Larne.* Volutions much flattened: two-thirds exposed, and slowly increasing in breadth, so that, in a diameter of 2·4 inch, six volutions may be counted, the centre being very neatly preserved. Section a flattened oval, terminating in a thin prominent keel—the whole sagittate from the projection into it of the preceding whorl. As compared with A. radians, the edge is sharper, and the sides flatter. Ribs in the centre whorls distinct, numerous, close, sharp, and having only a slight sigmoidal bend; but in the outer they become gradually more and more distant and faint, having sometimes between them other thin and very faint ribs. Of striæ there are only occasional traces. On the outer whorl the ribs have become very faint and distant, the sigmoidal character in them almost evanescent, and there is an appearance of longitudinal corrugation in the spaces between them. The beautiful sinuous septa are occasionally evident, and are remarkable for the great comparative distance between them, namely, ·44 of an inch, where the breadth of the whorl is only ·5. This is a pyritous cast. When very young, as they appear at Portrush, and also at Ballintoy, they approximate to A. radians, and might be thus described:—Discoid, whorls numerous, five in a small diameter of ·75 inch, about two-thirds exposed, increasing slowly in breadth; section flat, oval, with a sharp keel; ribs numerous, slender; but strong, and quite distinct, and having a space equal to four times their thickness between them; slightly sigmoid, the curve near the suture being nearly obsolete, and generally the curves being flatter than in A. radians or A. striatulus. It is a species common to the Ballintoy marls, and the indurated lias of Portrush, and also to the trap dike locality of Ballintoy. In one small Ballintoy specimen the ribs become very faint towards the aperture.

AMMONITES *elegans*, 1,
leviusculus, 2, } (Sowerby)—*White Park, Ballintoy.*
subradiatus, 3,

1. Tab. 94.—" Involute, much depressed, acutely keeled, volutions about three, inner ones about two-thirds concealed; radii twice curved, numerous, equal; keel distinct, entire; aperture acutely triangular; internal angles truncate."

2. Tab. 451.—" Discoid, carinated, umbilicated, obscurely radiated:

carina distinct: radii waved, alternately long and short, slightly elevated: umbilicus small, exposing parts of the inner whorls; aperture sagittate."

3. Tab. 421.—"Lenticular, umbilicated, carinated, and radiated; radii twice curved, obscure excepting near the margin, where they are bifid; umbilicus small; keel entire; aperture sagittate."

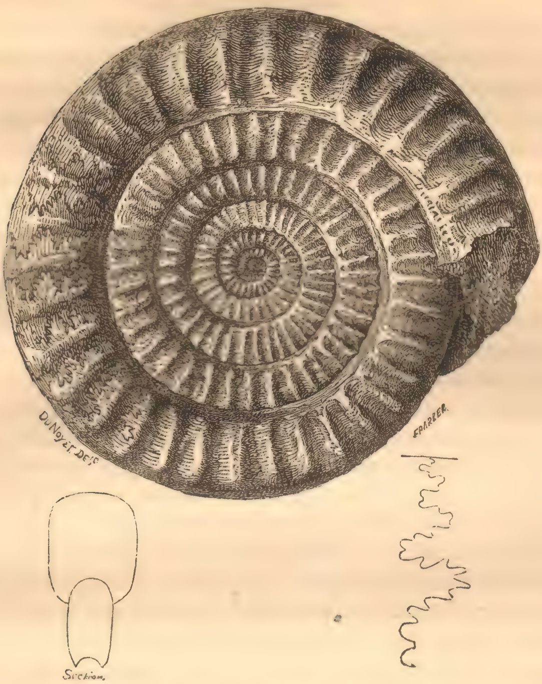
The difference indicated by these descriptions appears too slight for the establishment of three species. The radii are in old specimens so obscure as nearly to merge into the fine striæ: in A. leviusculus they are alternately long and short, whilst in A. subradiatus they are near the margin forked into two, or even three or four short ribs, forms which may easily run into each other. In A. elegans they are very fine and uniform. Roemer connects the three together, and adds also A. corrugatus and A. Murchisonii. Von Buch, in like manner, connects A. leviusculus and A. Murchisonii. In the fragments of a large individual, the diameter of which is six inches, the only one possessed, the radii are nearly obsolete, rising irregularly into slight puckerings of the surface at about one-third of the breadth of the whorl from the inner margin, and there merging into the striæ: but along the margin near the keel traces of the ribs very close together, and uniform in size, may be observed; these variations appear due to the different condition of the surface. The foliaceous septa are in part exhibited. Whilst, however, the condensation of Roemer is probably correct, so far as the first three synonyms, the addition of A. Murchisonii is at least doubtful, although the striæ on the surface of old specimens correspond in form to those of A. leviusculus, &c. The inner whorls of A. Murchisonii are (judging from Sowerby's figure), much more exposed, and the whole shell more involute; this, indeed, becomes very evident on comparing so large a specimen as the present with Sowerby's figure, the breadth of the whorl being much greater, and the curve sharper, the result of its greater involution. In addition to the difference in form of volution between A. Murchisonii and A. leviusculus may be added, from our specimen, the difference of the form of the foliaceous septa—Von Buch, for example, (Abhandlungen der Akademic Zu Berlin, 1837: s. 101), says the lobes are most remarkable from the parallelism of their sides; the two lateral lobes are scarcely smaller below than above; the secondary lobes are shallow. In none of these particulars will the description suit our specimen of A. leviusculus, in which the lobes are deeply sinuated by the secondary lobes, and these are again deeply indented. Roemer also states that the lobes are not much divided, and are moderately rounded. The septa are not sufficiently preserved to give a detailed description, but this is enough to show that A. Murchisonii and A. leviusculus are not the same. A. corrugatus may in like manner be a synonym of A. Murchisonii as a young individual, but not of A. leviusculus.

Ammonites *Lamberti* (Sow.)—*Larne*; dark calcareous clay or marl, but indurated.—In this beautiful species the ribs are curved forward over the front so as to meet in pairs, and form an imperfect crenated keel. Sowerby describes the ribs as rarely furcated, but generally alternately long and short. Bronn, however, describes the ribs as being in some cases simple and in others alternated with smaller ribs. Two varieties are found at Larne; in the one the ribs are simple, equal, strong, bent forward and connected in pairs, over the front; in the other they are furcated, the branches meeting in a similar manner, so as in either case to form a crenated keel.

Ammonites *Johnstonii*? (Sowerby)—*Ballintoy, White Park;* calcareous clay; another specimen is too closely allied to be separated, though still having ribs in the centre. This species is described by Sowerby from a flattened specimen in which the pearly coat alone had been preserved. This condition (flattening) would necessarily increase the apparent breadth of the external whorl, and make the proportional space occupied by the ribs less than it really is.

Ammonites *intermedius* (Portk.)—*Ballintoy; Ardclinis*, near *Garron Head;* section oval; the axis in the plane of the larger whorls being about one-fourth longer than the transverse axis; ribs not extending to the suture on the inside nor over the front on the outside. When the shell is preserved there are very delicate, almost obsolete striæ which bend forward and meet over the front. The front itself to the eye is quite smooth, but occasionally some irregularity may be discovered by the finger. Ribs are visible almost at the centre, and are sharper and proportionately longer in the inner whorls: occasionally also they are slightly bent. This species differs from A. communis, in not having forked ribs; from A. planacosta, in not having the ribs sharply bevelled over the front, though in some specimens traces of a continuation of obsolete ribs over the front may be observed, probably constituting another intermediate variety; from A. Conybearii, in not having a keel; and from A. Johnstonii, to which it closely approximates, in having the ribs closer together and proportionately longer; though in this latter respect it may be observed that Sowerby's description having been drawn up from a flattened specimen, the breadth of the volution will necessarily appear greater in proportion to the ribs than in the natural condition. The foliaceous septa occupy the space between two ribs, and are extended in broad digitate lobes over the front. In one specimen the foliaceous septa are distinct; they form a succession of sinuous lobes, augmenting in breadth

No. 17.



from the interior to the exterior of the whorl. In some specimens the mode of petrifaction appears to have been curious : in one, for example an outer whorl is at one end filled by the grey gritty limestone of the surrounding rock, whilst at the other, by the section, it appears half occupied by the limestone and half by white calcareous spar ; and again an inner whorl is entirely occupied by the spar. *Ballintoy ;* indurated shale of trap dike.—This specimen held to the light shows the traces of obsolete ribs or striæ over the front, apparently three between each pair. *Glenarm, Cairncastle, Tickmacrevan ;* calcareous or gritty grey limestone, same as *Ballintoy*—Where the shell is perfect, the front is quite smooth. In the inner whorls the depth is equal to the width, and in the cast the ribs, on coming to the front, where they appear slightly curved, vanish away without visibly passing over, though occasionally there is a trace of such passage sufficient to become perceptible to the finger, or under a strong light to the eye. As the whorls augment the breadth increases more in proportion than the depth, and the ribs become comparatively less until at length they have exactly the position of those of A. Johnstoni. *Ballygalley Head ;*

there appear to be two varieties of this species; the ribs of one being more distant from each other than those of the other, and its section rounder, the form of the septa is the same. *Island Magee, Gobbin's Head;* same rock, but with sparry fragments, resembling therefore the Aghanloo bed, which contains the A. Sampsoni; one specimen strongly exhibiting the character of A. Johnstoni. Another beautiful mode of petrifaction is exhibited by one of the specimens. The inner whorls are entirely filled with white calcareous spar; but the outer whorl is empty in the centre, the circumference being lined with spar, for about ·1 of an inch from which project towards the centre numerous acute crystals, the spaces between their opposite points being unequal according as the process of filling up has more or less advanced. In the figure the septum represented is not complete to the back; the siphuncle in this specimen, as is often the case, not being central.

AMMONITES *Sampsoni* (Portk.) Aghanloo, *Ballymaglin; Glenarm.* Limestone.—(Pl. xxix A. Fig. 13.)—Whorls four in a diameter of 2·25, two-thirds exposed; no decided ribs, though faint puckerings of the surface or obsolete ribs may be traced on the inner whorls. The outer whorl is remarkably smooth; but even here held up to the light there can be traced sigmoid lines approximating this species to the falciferi. These are all sparry casts and do not show the striæ, although with a lens they may be traced. The section is a depressed oval; the sides being very flat and the front quite smooth and rounded, without any trace of a keel.

A. *planorbis* ?—Calcareous marl; *Ballintoy.*—Small flattened smooth shelly specimen; no ribs visible; ·5 of an inch; four whorls; about two-thirds exposed, which from the rate of increase would make six volutions in the size of Sowerby's.

A. *armatus*—*Ballintoy, White Park*; clay.—Small shell about four whorls, is one of the varieties of this species; rather obscurely preserved in clay; portions of shell as in some of the bivalves.—In the inner whorls of another, not a large specimen, being little more than two inches across, the ribs rise into sharp knobs. Portrush Rock; doubtful; the scars appearing too far from the front.

AMMONITES *hastatus* (Young and Bird)—Lias clay; *White Park, Ballintoy.*—Only the front of part of a whorl of this specimen is seen; it is convex, but very much flattened, and very broad. The spines are very broad at their base; are flattened and rise perpendicular to the plane of the shell, and close to its front. In this specimen they are at least 1¼ inch long. Young and Bird say that in their example the spine was probably when entire 2 inches long. Young's locality is Hawksher Shore, which is part of his lower aluminous strata of the lias.—In another specimen is seen the uncertainty of relying too much on partial circumstances; the spines here are distinctly, as stated by Young, the prolongation of the ribs into a long spine; but they do not project over the back, but diagonally, forming a widely open angle with the side. The spines are not like knobs set on, but are distinct prolongations of the ribs, and very slightly furrowed. The swells between them are strong curves; concave outwards. Fragment of tolerably large A. *hastatus,* agreeing better with Young and Bird's figure, from the greater distance between the spines, and the greater magnitude of the tubercles they leave behind when removed; they are very large in this specimen. I only separate this from the last, to show the great apparent difference according to the state of preservation.

Two imperfect large ammonites, probably A. *rotiformis,* Antrim, *White Park, Ballintoy,* very calcareous.

BELEMNITES (*alveoli*) *Ballintoy*—Calcareous clay; very close chambers, and sharply conical; probably B. abbreviatus.

To these may be added, on the authority of Captain Jones, M.P., the tooth of an *Ichthyosaurus* from Tircreven Burn; vertebræ of *Plesiosaurus* from Carnmoney, recorded by Mr. Bryce, and teeth of *Lamna.*

An examination of this list is sufficient to establish some very interesting facts. The manner in which some of *the fossils* are localised, proves the greater subdivision of the oolitic system in this limited district than at first would appear to be the case; for example, the remarkable *Nucula rostralis* abounds in the calcareous grit of *Craig* and *Gortmore;* but the same description of rock, and the fossil also, is wanting in the other localities: it is associated with *cerithia,* equally abundant and equally local; Ammonites *multicostatus,* is confined to the same bed. Ammonites *Sampsoni,* is only found in a limestone, which preserves its character at *Ballymaglin* on the west and *Glenarm* on the east. Ammonites *intermedius,* though abundant from *Larne* to *Ballintoy,* is rare, if it occurs at all, on the *Magilligan* side; *Cardium striatulum,* characterises a shale bed at *Colin's Glen,* near Belfast, and a similar one at *Lisnagrib,* in Derry; Avicula *contorta,* in a similar shale at *Lisnagrib* and at *Larne; Pecten Valoniensis,* is a fossil associated with stylolites on the Continent, and hence as here, very closely related to the muschelkalk. The fossils generally are those of the lias or lower portion of the oolitic system, but some seem to point to a higher division. *Pecten quinquecostatus; Pecten æquicostatus,* var. *longicollis; Inoceramus Hamiltonii, Gervillia,* are fossils which mark a portion of the lower greensand, the bed being a fine grit, with very little admixture of silicate of iron. On the face of Ben Evenagh it would be useless to endeavour to build its fallen fragments into a determinate section; but these remarks will be sufficient to induce other observers at the more favorable localities of the eastern shore of Antrim, to endeavour to complete what is here deficient; and bearing in mind the individuality of mineral and fossil characters preserved by some of these beds, even when only one or two feet thick, at distant and unconnected localities, it cannot be doubted that a very fine section of the oolitic and cretaceous systems might be constructed in the County of Antrim.

NOTE.

On the occurrence of liasic and greensand fossils, associated together in the same bed, see page 132.

In noticing (page 109) this remarkable mixture of beds of two distinct formations, beds not naturally in immediate succession to each other, I was inclined to consider it the result of a slip, tearing up the lias clay and mixing its fossils with the greensand. The Gryphites, though perfectly characteristic, are much worn and broken, which supports this view; but a difficulty arises out of the condition of the fossils, as they are filled with the greensand. If, indeed, the Gryphites had been exposed, by the wearing away of the clay, for a considerable time prior either to the deposit of the greensand, or to the slip, they might have been emptied of the clay and refilled by the sand; but in either case the fact itself is full of interest and instruction: and it is to be regretted that the generally disturbed or slipped state of the strata in Magilligan, must render a positive demonstration of the mode in which this mixture has been effected almost impracticable.

The following analyses by Dr. Apjohn, were received too late for insertion in their proper places; the two first complete the view taken of the metamorphosis of the Ballintoy marls into the Portrush Rock; and the third is an additional datum of comparison with the basalt:—

PORTRUSH CLAY.	
Matter insol. in M. Acid,	56·90
Alumina,	1·76
Per ox. Iron,	7·43
Carb. Lime,	19·02
Carb. Magnesia,	3·94
Water and loss,	10·95
	100·00

PORTRUSH ROCK.	
Silex,	57·44
Alumina,	23·48
Per ox. Iron,	10·16
Lime,	5·94
Magnesia,	2·68
	99·70

BASALT OF CONTACT, FROM SLIEVE GALLION.	
Silex,	39·72
Alumina,	14·32
Prot. ox. Iron,	27·87
Lime,	4·15
Magnesia,	4·00
Soda, Water, and loss,	9·94
	100·00

CHAPTER V.

BASALT.

The general outline of this great formation on the west has been traced in the preceding chapter. On the east it extends into and over the County of Antrim, where it rises again to a high elevation, and rests generally on the chalk—lias, new red sandstone, and carboniferous rocks bassetting out from under, and sometimes supporting it. In the interior of this area it sinks to a low level, and along the western shore of Lough Neagh and Lough Beg, and of the Bann, is so much concealed as to appear only in isolated lumps or small ridges, rising here and there above the general level of the detritus and bog. This detached character is indeed visible in all the interior parts of the basaltic district, the successive beds resembling the strata of ordinary deposits having been worn away, and reduced to isolated masses or ridges. Many examples might be cited—such as the Giant's Sconce, near the road from Coleraine to N. Limavaddy; Dunmull, near Coleraine, a fine tabular mound of rudely columnar basalt; Knockloughrim, near Castle Dawson; and in all these examples, as well as in many minor patches, the beds do not sink on one side under other strata, and rise up on the opposite side as in ordinary strata, but are scarped all round, and are evidently, therefore, portions of beds—once continuous over the whole space. The cause of this great destruction and removal of the basalt is to be found in the mixture of soft and hard beds, and the facility with which a large portion of them, including some of the more solid in appearance, disintegrate. On the northern shore, from Portrush to Magilligan, the wear of the soft amygdaloidal beds has led to the breaking down of the harder, producing the jagged outline of that coast; and in a similar manner, at a more ancient epoch, the rocks of the interior must have been worn away.

To understand this, it is necessary to know the exact constitution of the basaltic mass; and for this purpose the following sections may be studied:—

At Down Hill.—The base is amygdaloidal, and penetrated by numerous veins of mesotype. A beautiful arch has been worn through it.

Above this, 120 feet of basalt, hard, highly crystalline, and slightly columnar.

—— 2·6 — Ochreous claystone, with disseminated crystals of iron pyrites and carbonate of lime.

15·0 — Amygdaloid, soft and clayey, traversed in all directions, chiefly horizontally, by veins of fibrous calc-spar.—Hydro-carbonate of magnesia imbedded.

Basalt, hard, crystalline, and columnar on the top. The two hard beds are therefore separated by 17 ft. 6 in. of soft, easily decomposable rock.

Umbra and Woodtown.—In proceeding up the stream, the rocks are:

	ft.	in.	
1.	—		Basalt, hard crystalline, like greenstone ; bottom not seen.
2.	8	0	Amygdaloid, with veins and seams of iron-clay, and thin bed of hard basalt.
3.	5	0	Do.

Then irregular beds of amygdaloid and trap, succeeded by amygdaloid very vesicular and full of calc-spar, quartz, &c., and finally by basalt, very hard and conchoidal in fracture.

The Merrick Stone (Woodcut 1, page 25) belongs to this system, and has belonged to a point 60 or 80 feet higher in the precipice. In this section the amount of readily decomposable rock is very great.

Carnowry, Rock Head.

1.	30	0	Chalk, covered by a bed of rolled flints and clay.
2.	32	0	Basalt, slightly columnar, uneven at bottom, conforming to the hollows in the chalk.
3.	1	0	Ochre or bole.
4.	33	0	Basalt, slaty, more vesicular than the bottom bed.
5.	2	0	Bole, approximating to amygdaloid.
6.	10	0	Amygdaloid, dark.
7.	46	0	Basalt, hard, columnar.
8.	1	6	Ochre or bole.
9.	8	0	Basalt, slaty.
10.	70	0	Basalt, hard, compact, dense, and columnar.

In this section, therefore, there are 148 feet of dense, semi-columnar basalt, 41 ft. of slaty basalt, and 15 ft. 6 in. of ochres and amygdaloid.

Descending in another direction.

	ft.	in.	
1.	35	0	Basalt, compact, dense, with vertical fissures.
2.	15	0	Amygdaloid, clayey, dark, very vesicular, and full of zeolites.
3.	50	0	Basalt, hard, dense, crystalline, slaty fracture, concretionary structure.
4.	3	6	Bole, red (5 inches) at top, passing below into reddish amygdaloid.
5.	30	0	Basalt, hard, vesicular, spherical concretionary, slightly columnar.
6.	4	0	Bole (6 inches) and amygdaloid.
7.	20	0	Basalt, hard, compact, passes below into amygdaloid, dark, containing quartz, apophyllite, chabasie, calcedony, with seams or lenticular masses of the harder rock imbedded in it; bottom not visible.

The hard rock is here 135 feet, the soft 25 feet.

Benyevenagh.—Ridge at top removed from the precipice in detached outlying masses.

2.			Basalt, hard, but slightly amygdaloidal, spherical concretionary, the lower portion irregularly cellular.
3.	5	0	Amygdaloid, reddish, very vesicular, 13 inches of the top has been decomposed, and subsequently indurated into iron-clay or bole.
4.	24	0	Basalt, hard, slightly columnar at the top, decomposed and brittle, passing insensibly through the slaty to the hard portion.
5.	4	6	Amygdaloid, surface red, interior dark, vesicular minerals abundant.—Mesotype, arragonite, steatite.
6.	38	0	Basalt, rudely columnar, like greenstone, vesicular.
7.	5	6	Amygdaloid, red at top, almost pure clay or bole.
8.	40	0	Basalt, vesicular, becomes occasionally an amygdaloid, with lenticular hard masses involved in its substance. Veins of skolesite, semi-opal, chabasie covered by per ox. of iron, mesotype, &c. This bed, in all its characters, corresponds to No. 8 of Carnowry descending section.
9.	8	0	Basalt, hard, columnar, conchoidal fracture, dark and heavy.
10.	4	0	Amygdaloid, red, eight inches at top indurated clay or bole.
11.	20	0	Basalt, dark, vesicular, of variable hardness, very like pumice stone.

	ft.	in.	
12.	6	0	Basalt, hard.
13.	0	0	Seam of red ochre and amygdaloid, full of mesotype, yellow carbonate of lime; skolezite.
14.	0	0	Basalt, hard with micaceous iron ore, and a seam of minerals principally stilbite.

The proportions here are—hard and columnar varieties, 76 feet, vesicular and intermediate in character 60; soft, 19; and there are also examples of decomposition and subsequent induration, through the influence of the next basaltic flow.

The slipped portion of Benyevenagh admits of examination.

	ft.	in.	
1.	0	0	Basalt, hard columnar, and partly slaty; of unequal thickness, with a small portion of amygdaloid.
2.	4	0	Amygdaloid, red, at top ochreous, very vesicular.
3.	25	0	Basalt, globular concretionary; slightly vesicular; contains steatite, and is decomposed for a considerable depth.
4.	4	6	Amygdaloid, 6 inches at top, becoming bole: contains mesotype, chabasie, &c.
5.	12	0	Basalt, hard, vesicular; traces of micaceous iron, and minute particles of augite.
6.	0	0	Amygdaloid, very vesicular; cavities coated with chabasie in beautiful crystals; passes into.
7.	45	0	Basalt, vesicular, tufaceous, resembling pumice; includes masses and seams of a harder variety.
8.	8	0	Basalt, hard; highly crystalline; slightly magnetic.
9.	4	6	Amygdaloid, red, compact, vesicular, veins appear to be felspathic.
10.	8	0	Basalt, compact; very heavy; charged with oxide of iron; micaceous iron and augite.
11.	5	0	Amygdaloid, dark; containing steatite and chabasie.
12.	6	0	Basalt, hard; slightly columnar, and under this a thick bed to bottom of amygdaloidal basalt; lower portion, being more cellular, includes lithomarge, levyne, steatite, &c.

The hard beds are here 53 feet; vesicular and tufaceous, 45; soft, 17.

In this, as in the preceding, are examples of a graduation from the hard basalt into the soft amygdaloid, and of hard portions being immersed, as it were, in the soft.

	ft.	in.	***Avish,*** (805 feet) ***descending.***
1.	0	0	Summit, thickness not determinable.
2.	6	0	Amygdaloid, dark, ochreous at top.
3.	25	0	Basalt, hard, dark, compact.
4.	20	0	Amygdaloid, red on surface.
5.	6	0	Basalt, hard, compact.
6.	6	0	Amygdaloid, very vesicular, abounding in minerals, Levyne, &c.; the lower portion is more compact.
7.	0	0	Decomposed for 6 feet, including masses of a harder variety; depth not determinable.
8.	7	0	Amygdaloid.
9.	0	0	Basalt, highly crystalline.

In this section, there are 45 feet of soft and decomposed rock.

The great slip called the Castle Rock—see Woodcut 15, page 110—includes a bed four feet thick of amygdaloid, red and vesicular, the cells being left empty by the decomposition of the minerals they contained.

On the Coast.—Dunboe parish, townland of Freehall Dunlop; hard basalt rests on bole and amygdaloid full of Analcime, Mesotype, Mesolite, &c., in distinct crystals. The amygdaloid is traversed in every direction by veins of an ochre colour, hard, and like jasper.

At Port Vantage.—A deep cut, still occupied by a small stream, displays the same arrangement; dense, finely crystalline basalt resting on red semi-porphyritic amygdaloid; and such examples of arrangement and of variety of structure might be multiplied all round the basaltic escarpment, as well as within its area; hard basalt, resting on amygdaloid, having been observed in Ballyscullion, Termoneeny, Maghera, and Magherafelt parishes: in short, the combination of basalt, amygdaloid, and ochre is common to the whole basaltic district.

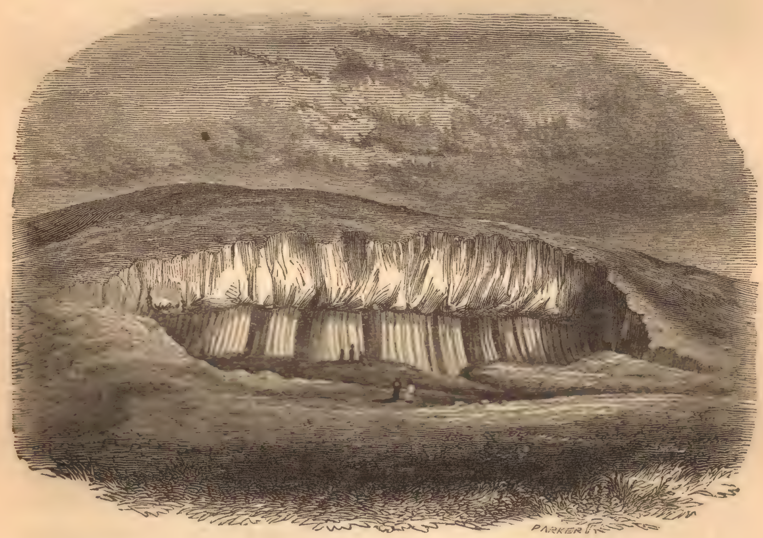
From a careful examination of the preceding sections, and still more from an inspection of the rocks themselves, the following deductions may be drawn:—

1. The very hard and highly crystalline basalts are tolerably persistent, not readily disintegrating.
2. Softer varieties have existed, in which decomposition has gone so far, that the mass is now an amygdaloid, having large lenticular portions of the harder rock still immersed in its substance.
3. That the amygdaloids have been decomposed on the surface, and subsequently indurated into bole—this change occasionally ending in the formation of a species of jasper.

4. That the amygdaloids and more easily decomposed basalts have formed a considerable portion of the total thickness, and hence, that the amount of hard rock to be removed from the surface of the ground, after the processes of wear and denudation, was much less than is generally supposed.
5. In looking closely at the basaltic cliffs, it is impossible not to see a passage in the one case, from the hard rock to the soft by decomposition, and in the other, from the soft to the hard by igneous induration; and thus to obtain a demonstration that not only the flows of basalt were successive and distinct, but also that a considerable time must have elapsed between each.
6. It may be reasonably conjectured that some of the amygdaloidal beds were originally poured out rather in the state of volcanic mud than of lava; and that their induration and vesicular character were due to the action of the succeeding flow of basalt.

The occurrence, in these sections, of highly crystalline beds resembling greenstone, deserves notice, in connexion with the same description of rocks at Portrush, &c., as it proves that such a form of rock was common in the regular basaltic flows; and the slaty structure of other beds is equally interesting, as it occurs again at Fairhead; and though at present there is no conclusive evidence to prove that any of these beds are metamorphic, there are unquestionably strong points of resemblance between some of them and the intermediate rock of Portrush. The truly prismatic basalt is confined to narrow limits; within this district it is only found in Ballywillin parish, on the road from Portrush to Ballymoney, and in Craigahulliar, and may be considereda portion of the Causeway prismatic rocks. In respect to the position of these beds, as compared with those described, there is some difficulty, all being so closely related in position to the chalk. If the basalt of the low ground between Portrush and Coleraine be considered a bed, corresponding to one of the beds of Benyevenagh, &c., it underlies the prismatic hill of Craigahulliar; but there are other detached portions, for example, the rudely columnar Dunmull, which, if continued, would pass over it; it is, therefore, probable that the now prismatic basalt, alternating as it does with massive basalt, was ejected at intervals within the great basaltic period, its peculiar condition being a local phenomenon consequent on some modifying circumstances, the nature of which can only be conjectured ; the appearance of the massive basalt immediately over the columns of Craigahulliar (Woodcut, No. 18), divided into large angular fragments, and retaining a rude columnar tendency, indicates, however, that the upper portion of a bed may have cooled into massive, whilst the lower became prismatic basalt ; and hence, that the varying thickness of the beds, and consequently varying times of cooling, may have influenced the result, but the occurrence of prismatic basalt at Lough Neagh, where it is also, as here, close to the synclinal line, or line of depression, is remarkable.

No. 18.



Assuming that the lumps of basalt immersed in the chalk prove the soft state of that deposit, when they were dropped into it, the basaltic flows must have commenced at a remote period of the cretaceous system ; and if the Portrush augitic rocks proceeded from an earlier ejection, they may have commenced even before that epoch ; but this is a doubtful and difficult question. The total time during which the basalt and volcanic muds continued to be poured out must have been very great ; and judging from the thickness of the lignite bed (upwards of six feet) between two beds of prismatic basalt at the Causeway, as well as from the facts already cited, was composed of periods of violence, separated by intervals of quiet, as in the processes of existing volcanoes. The mode in which the several beds are deposited, one on the other, is instructive; for, though there are undulations of surface, there are not those deep furrows which mark the upper surface of the chalk: hence it seems reasonable to believe that the latter, often accompanied by rolled pebbles, as well as filled up with clay and flints, were the results of aqueous action prior to the basaltic flow, and not of friction of its moving mass; and in this way also the flints were probably disengaged from their matrix. Of other facts may be mentioned the occurrence in Ballygonnybeg townland (Sheet 48), of a variety of basalt so minutely concretionary as, on weathering, to look like a conglomerate, and finally to become a basaltic gravel; a variety frequently met with in the County of Antrim. 2ndly, A curious fissure in the trap of Ashmaduff townland, parish of Dungiven, which is filled up with basaltic gravel, cemented together by calc-spar, the crystals of which shoot into cavities and line the sides. 3rdly, The Pots of Legavennon and Leganannim, which are deep indentations or excavations into

No. 19.

the basalt itself, and not connected with that undermining wear of the substrata which has produced the wide bays of the chalk escarpment. Popularly they have been ascribed to water-spouts; but comparing them with lesser examples, such as the Gap at the base of Stradreagh waterfall, it seems probable that the mode of their excavation was similar—namely, through the action of water falling from above, and possibly from a much greater height than their present summits.

Following the course of the basalt on the Map, it is seen resting on the chalk at the White Rocks and Dunluce, at an elevation of upwards of 60 feet; then descending at its base below the sea-level till at Down Hill it again visibly rests on the chalk, and its base continues to rise in elevation as the secondary strata crop out from under it. This variation might naturally be expected on approaching or receding from the edge of the great chalk basin, in which the basalt has been erupted; but its sudden rise or depression on the line of strike being necessarily independent of the natural slope of the basin, Dr. Richardson explained it by supposing great depressions of the chalk, in some measure connected with the appearance of the peculiar columnar variety of basalt. If this explanation be in part adopted, and the depression of the chalk be considered due to faults either antecedent to or at the time of some of the eruptions of basaltic lava, the basalt may have filled up the inequalities of the surface, and, though the level of its base might be irregular, there would not necessarily be a similar irregularity on the surface; and hence, it would be impossible to detect on the surface alone the places of such depressions. The soft substrata of the lias, by yielding to pressure, facilitated such depressions independently of oscillations from internal disturbance. If, however, the western edge of the basin, and the numerous and deep indentations in its line be carefully examined, and the effect which would be produced by another flow of basalt filling up all these inequalities, and connecting together the several chalk projections of Benyevenagh, Keady, Donald's Hill, and Benbradagh be considered, it will be evident that very similar appearances would be the result; and hence, that it is not improbable that wear or denudation may have had its effect also on the northern edge of the basin prior to some of the basaltic flows. If such has been the case, the basalt in part of its course, may perhaps rest on some of the liasic strata; at Corick (an isolated mass, see Plate E, fig. 1,) it rests on the new red sandstone; near Craignashoke (Plate F. fig. 2,) it comes in contact with the grits of the lower portion of the carboniferous system; and at Fair Head, in Antrim, with the coal strata; whilst at Carntogher it reposes on the mica schist; having thus indiscriminately flowed over the whole range of the strata, modified as they had previously been by wear and denudation.

This review of the basalt will be concluded by a detailed list of its varieties, drawn up, as well as the list of minerals, by Mr. Thomas Oldham (Geological Assistant), a gentleman well versed in mineralogy, with a view to point out the probable metamorphic condition of some of its beds.

DETAILED EXAMINATION of the MINERAL STRUCTURE of the BASALT, in comparison with the AUGITE ROCK and altered LIAS of PORTRUSH.

There are several modifications of the Portrush Rock; the first stage of the altered lias is simply a high degree of induration, the imbedded organic remains still continuing scarcely affected, and the rock retaining its slaty character and bedding (seen at E. Skerry.)

In the next stage the rock, still more indurated, has in a great degree lost its slaty structure, the fossil impressions being either coated or filled with iron pyrites. It next becomes decidedly conchoidal in fracture. When examined closely by the aid of a lens, is distinctly crystalline, and scarcely a trace of organic remains can be seen. Small nodules and grains of iron pyrites are disseminated. In one specimen of this variety, there is a small belemnite imbedded, *the cavity of which is filled with the crystalline augite rock which underlies.*

This highly indurated and cherty rock abounds with fissures, which render the rock somewhat prismatic in structure. The surfaces of these fissures are frequently covered with a thin film or coating, of a light bluish-grey substance, exactly resembling the deposit formed by the fumes on the sides of a furnace. This film is too thin to afford a sufficient quantity for analysis.

A very hard greyish siliceous rock, semi-crystalline, and having numerous small crystals and grains of iron pyrites imbedded, occurs at No. 95, Sheet 3. It is again seen at No. 85, B., in junction, on one side, with the ordinary black cherty layer, and apparently on the other side with the crystalline greenstone, forming a layer of from 1 inch to 1½ inch thick. Here it is irregularly marked or spotted, with some substance of a darker hue, the nature of which is not ascertainable. A similar rock is also met at the 2nd W. Skerry.

Again, at No. 91, townland of Portrush, a rock occurs nearly similar, essentially quartzose, but slightly cellular, the cavities being filled with zeolites. In one place, there is the appearance of a cast of an ammonite filled with zeolites (*mesole, chabasie, stilbite, apophyllite*). The appearance and character of these specimens is so different from either the black cherty rocks which appear to overlie them, or the crystalline greenstones, as to lead to the belief that they are the results of metamorphic action on a thin layer of different character from the accompanying shales, probably a calcareous sandstone.

In the townland of Corrstown, Sheet 3, No. 99, rocks occur, so similar in every respect to the last stage of the altered lias, that there can be no doubt of their identity. These extend the lias farther inland than was supposed, and taken in connexion with the occurrence of a rock at townland of Glebe, No. 72, equally identical with the second or less crystalline stage of the augite rock (to be noticed), will prove interesting.

Descending from the lias, the rock immediately below it appears to have bedding and other conformability to the incumbent lias. It is difficult to procure a good cross fracture of this variety; it is traversed and split by so many cracks, that it yields at once to the hammer. It appears to be somewhat siliceous, the augite in small crystals, felspar not abundant, and somewhat granular.

The felspar next increases in amount, the quartz decreasing, till the rock becomes a fine-grained, though not highly crystalline, greenstone, essentially composed of augite (crystallized) and compact felspar of green, or yellowish-green colour.

The rock next becomes more largely crystalline, and lighter in colour, and passes by insensible degrees into the very highly crystalline or normal state. In this stage apophyllite seems to be an universal ingredient; being traceable in all the specimens, and would appear to be the cause of the marked change in colour.

This variety is traversed by very many veins of minerals, and also by veins of the rock, similar in composition, but differing in character from the size of crystals or predominance of one of the ingredients. For the most part, the felspar is compact, of a yellowish-green or olive colour, but small patches occur in which it is crystallized. Carbonate of lime is irregularly but not sparingly disseminated; sometimes also occurring in crystalline layers coating the cleavages?

In the veins, fine specimens of the following minerals have been found:—

Apophyllite, in remarkably large, beautiful, and distinct crystals, of the primary and slightly modified forms.

Augite, in large and well pronounced crystals.

Chabasie, in fine rhomboidal crystals.

Felspar, rarely in crystals.

Laumonite (very rare).

Mesole, in extreme beauty.

Mesolite.

Mesotype.

Natrolite.

Stilbite, both in the ordinary sheaf-shaped aggregations and prehnitiform.

Heulandite, in small, nearly transparent crystals.

Stellite (Thomson).

Iron Pyrites, in grains.

Analcime has not been discovered, and its absence is somewhat remarkable, it being so very common in all the trap rocks. These are the minerals in the highly crystalline variety of the augite rock; while the intermediate rock adjoining the lias, yields only the following:—

Mesotype (natrolite).—This occurs in veins close to and almost in the hardened lias; of a remarkably snow-white colour; dull and very compact.

Harringtonite (Thomson), in veins or layers.

Apophyllite occurs but rarely, lining cavities, alone and not as in the normal variety accompanied by other zeolites.

Augite, rarely in distinct crystals.

As regards the apparent passage of these rocks into one another, one circumstance is perhaps worthy of remark: that though the two rocks appear to be absolutely fused into one another, so that the line of junction in the fresh fracture cannot be accurately traced, even with the assistance of the lens, the searching effects of the weather on the exposed surfaces clearly disclose it, the rock weathering in a distinct line along the junction; the metamorphosis having not merely changed the mineral structure, but obliterated the line of separation of the beds. This is seen in all the specimens which appear to have been taken from the exposed parts.

The Magilligan section affords the following series (descending):—

1. A hard siliceous greenstone of greyish-green colour; olivine imbedded in small portions; also mesotype in small nodules.
2. Dark-coloured, highly crystalline basalt, olivine imbedded; very felspathic, the felspar of a dark green colour. This rock is very similar to the slightly modified rock of Portrush.
3. A soft clayey amygdaloid, decomposing into a rich and deep red bole; abounds with carbonate of lime, chabasie, steatite, &c.

4. Finely sub-crystalline, dense basalt, fracture peculiarly rough and uneven; arragonite in small quantity; chlorophæite abundant.
5. An exceedingly vesicular, clayey, saponaceous amygdaloid, the cavities filled with zeolites in great abundance and considerable variety; but from the smallness of the cavities they do not acquire any beauty. Seams of bole.
6. Dense, close grained basalt, with larger crystals of felspar imbedded; also small globules of chlorophæite and mesolite.
7. A dark-coloured, highly vesicular, and felspathic amygdaloid, of a reddish tint; chabasie plentiful; steatite and earthy phosphate of iron?

   This amygdaloid is very flaky, breaking into thin flat pieces.
8. A richly crystalline, dark, felspathic trap; small portions of dark-coloured olivine imbedded, and small cavities filled with chabasie, apophyllite, mesolite, &c.

   This bed is undistinguishable from some varieties of the Portrush Rock. Through it there appears to run veins of amygdaloidal rock; abounding in mesolite, chabasie, mesole, steatite, carbonate of lime, bole, &c., both in cavities and in irregular strings or veins.
9. Highly crystalline, dense, and felspathic basalt, being similar to No. 6.
10. A reddish, very soft clay amygdaloid, porous, and decomposing readily into bole: in it occur chabasie, carbonate of lime, and levyne.
11. A very vesicular, felspathic, amygdaloidal wacke; the cavities frequently empty, also lined with chabasie, analcime, carbonate of lime, steatite, &c.
12. Hard, dense, finely crystalline, and felspathic, with numerous small portions of olivine imbedded; small portions of chlorophæite also occur.
13. A reddish coloured claystone amygdaloid, very vesicular, chabasie, levyne, mesole, mesolite, analcime, carbonate of lime, stilbite, steatite. This appears to be the same bed, which, in its continuation at Avish, yields such beautiful specimens of levyne.
14. A dense, highly crystalline trap, felspathic, and abounding in iron, which, when exposed, gives the rock a very red colour. Small nodules of chlorophæite and chabasie occur imbedded.

This bed is also very similar to, and scarcely to be distinguished from, the second or intermediate stage of the Portrush Rock.

It thus appears that in this series (which in a small space affords almost every variety of the trap rocks which occur in the great plateau) there are at least two, perhaps three, of the beds or layers, which, in character and constitution, are very similar to the modified augite rock of Portrush; and it is also worthy of notice, that both here and throughout the trap district, those specimens which exhibit the nearest approach to the bedded variety, or first stage, are themselves, in almost every instance, of that slaty or tabulated character which so distinctly marks some of the trap layers.

Again, on comparing the modified trap rocks of Portrush with the entire series of basaltic specimens, it is surprising to find such a striking resemblance in many of them. They differ, however, generally in colour, owing, it would seem, to a greater amount of iron; they never assume the highly crystalline character of the Portrush Rock, and in most cases, where the ingredients can be distinguished, the felspar is equally crystallized with the hornblende or augite, (a thing rarely occurring in the augite rock at Portrush.) These, however, are but minor differences, and in general character, &c., they are so similar as to give rise to many interesting considerations.

To give a list of all the localities where these occur, would be to give a string of mere numbers. A few only will, therefore, be cited from various and distant portions of the trap country, to show that this similarity of character is not confined to any particular portion of the district.

At No. 69, Sheet 17, (parish of Balteagh, townland of Upper Drumsurn), is a trap rock, highly crystalline, and undistinguishable from the rock at Portrush, where it occurs slightly modified from its normal character, and again at No. 59, (same sheet). Nos. 60, 56, 41, are rocks very similar to the second, or slightly bedded variety of the Portrush Rock. Similarly at Sheet 6, No. 82, 88, 128.

Sheet 7, No. 14, 39, similar, but more like ordinary basalt.

Sheet 7, No. 63, very felspathic and compact, like the bedded variety.

The fine grained, slaty, felspathic variety, or that which shows evident bedding, is well seen at—

Sheet 32, Nos. 126, 127, 121, 130, 88, 89.

Sheet 25, Nos. 236, 241 B, 228.

Sheet 7, No. 63; Sheet 12, No. 47.

Sheet 27, Nos. 11, 22.

Again at Sheet 37, No. 20; Sheet 42, Nos. 28, 31.

Sheet 10, Nos. 51, 73, 76.

The very fine-grained trap from Carrick-a-rede, which, from the small disseminated portions of chlorophæite, has to the eye somewhat of a porphyritic appearance, is again distinctly repeated at Craigahulliar (Sheet 3, No. 38, B.), in Ballywillin parish; but does not occur so well marked in any other locality within the range of our specimens: similar remarkably fine-grained trap (wanting the imbedded chlorophæite, but in which are occasional cavities lined with obsidian,) occurs at Crossreagh townland, Sheet 3, No. 34, 35, and 37, and townland of South Ballylagan, at Sheet 3, No. 30. In all these cases this remarkably compact variety occurs in columnar ranges.

A dike in Fermanagh (Sheet 5, No. 19), is a highly crystalline rock, essentially composed of hornblende and felspar. The hornblende highly crystalline, the felspar both compact and crystalline, the crystals occurring in cavities in the rock; magnetic iron pyrites is abundant, occurring both in large imbedded crystals and in irregular veins, while the percolation of water has coated both with the oxides of iron, imparting bright and varied colours to the minerals. This rock presents very little resemblance to that at Portrush. The number of basaltic dikes, specimens to which reference could be made, is but small; the rock of Lady O'Cahan's Bridge is finely crystalline basalt, having a few long slender prismatic crystals of felspar (dark) imbedded, and holding small nodules of zeolites. Another dike of nearly similar basalt occurs near Moneymore, in the townland of Ballymully.

The comparison, therefore, of these rocks, shows that each modification of the supposed metamorphic portion of the Portrush Rock, has its representative, so to speak, in some of the beds of the great trap range.

Finally this examination shows that there are two classes of dikes, the one like that of Lady O'Cahan's Bridge, belonging to the regular basalt; the other, like the Fermanagh dike, exhibiting none of the peculiarities of the basalt, and proceeding, it would appear, from a different source; and hereafter it will be shown that both species occur in districts far removed from the great basaltic field. It shows also, as has been premised, that metamorphic alterations may have been far more extensive amongst the strata classed with basalts than has usually been supposed, though, as already remarked, no conclusive evidence can be obtained, where rocks have arrived at such a high state of crystalline structure; and to these proofs may be added the numerous examples of veins, like Lydian stone, in the Antrim basalts, and the singular slaty character of some of its varieties, particularly that which, occurring close to Fair Head, may have been a metamorphosed shale of the coal strata.

How widely different, then, is the great basaltic field from either one vast sheet of lava, or even from several successive flows of the same melted stony matter, as there is probable evidence of several forms of erupted matter ranging from soft ochreous mud to hard basalt, and evidence nearly as probable that, whilst the surface of the first beds was suffering decomposition, the usual course of natural events proceeded, and new deposits, including beds of lignite, were formed in strata upon them, and being enveloped by the subsequent flow, were metamorphosed and assimilated in structure to the basalt. At Portrush the evidence of such change is complete; and though not equally so here, the analogy is too strong and too natural to be entirely rejected. The elevation of the basalt is greatest along the east and west sides of the Basin, being on the east in Antrim at Knocklayd (1685 feet), Trostan (1810), Agnew (1558), Divis (1567); and on the west at Benyevenagh (1260), Keady (1101), Donald's Hill (1315), Benbradagh (1531), Carntogher (1521), White Mountain (1773), Craignashoke (1996), Slieve Gallion Carn (1623); and as the beds have an inclination inwards, corresponding to the subjacent strata, this difference of elevation of the interior and exterior portions of the basin, though increased and modified by denudation, is not entirely due to it. In whatever direction the basalt flowed, it could not have arranged itself conformably to the opposite sloping sides of the same basin; hence it is evident that the central depression of the chalk basin along the line of the Bann is due to subsequent disturbance, and the abrupt depressions or faults of the chalk on the northern coast may therefore, in part, be due to the oscillations which accompanied it. The thickness of the whole mass, classed with the basalt as erupted rocks, is necessarily variable from the great amount of wear and denudation of the beds composing it; it rarely, however, exceeds from 400 to 700 feet, as may be thus estimated :—

	feet.		feet.
Chalk, at Stradreagh, is elevated,	540	Chalk, at Benbradagh, .	1238
Summit of Benyevenagh, .	1260	Summit of ditto, . .	1531
Thickness of Basalt,	720	Thickness of Basalt,	293
Chalk, at Donald's Hill, .	840	Chalk, at Craignashoke, .	1263
Summit of ditto, . .	1315	Summit of ditto, . .	1996
Thickness of Basalt,	475	Thickness of Basalt,	733

Chalk, at Slieve Gallion Carn,	1300
Summit of ditto, . .	1623
Thickness of Basalt,	323

CHAPTER VI.

TERTIARY—CALCAREOUS CLAYS.

The beds here considered anterior to, and distinct from, the overlying beds of gravelly clay, gravel, and sand, usually called diluvium, are frequently met with in the County of Derry, and from the nature of their composition and imbedded pebbles, appear to be connected with the wear and disintegration of the chalk and basalt. That they are distinct from the superficial detritus is proved by the abrupt change from a calcareous to a non-calcareous clay, or from the calcareous clay to a clayey gravel, so clearly marked on the banks of streams which pass through them, as well as by the abundance of chalk and basaltic pebbles in the one, and their rarity or total absence in the other; and further, the presence of marine shells supplies a conclusive reason for separating them from beds or heaps of gravel, sand, and clay which contain none. The shells in species are extremely limited, though in individuals abundant; Turritella terebra, Cyprina Islandica, and Nucula oblonga, were all which a diligent search could supply; the first is confined to the bed near Bovevagh old church; the second is always so broken up that little more than the hinge can be identified; the third is the characteristic shell of the deposit, and notwithstanding its fragile nature, is found perfect. Taking that shell, therefore, in connexion with the order of arrangement, these beds may without hesitation be classed as tertiary, no certain locality of still living Nucula oblonga being as yet known: and placed in the more recent portion of the tertiary, as having followed the eruptions of basalt, and as approximating so closely, in their organic contents, to the recent epoch.

On entering upon their consideration, the first fact which arrests attention is their limitation westward: they do not pass beyond Muff, and an inspection of the locality shows that a projection of the schists screens the basaltic range from the valleys beyond it; hence, it may be assumed that the physical features of the country in respect to its rocks, have suffered little comparative alteration since the deposition of these clays. The little stream near Muff church, in its winding course, cuts through the clay at least nine times; the thickest and lowest bed being 133 feet, the thinnest and upper bed 195 feet above low-water mark. The beds are of irregular thickness, from 2 to 10 feet, and are covered by gravelly clay, gravel, or sand, the gravelly clay continuing down the river to within 900 feet of Muff church, and then giving place to gravel, and in the flat to clayey sand and clay. The calcareous clay is of a deep plum-colour, the gravelly clay of various shades of grey depending on the schists, the decomposition of which has produced them, hence the most marked line of demarcation is here afforded by general appearance, mineral structure, and organic contents; the formation of the lower clay being connected with the chalk and basalt, that of the upper with the schists. The Faughanvale river exhibits similar facts, the calcareous clay being domed over by the gravelly clay and that again by gravel; and the elevation of the beds above the sea being 102 and 111 feet. In the boundary stream of Gortgar and Gresteelbeg, the calcareous clay attains sea levels of 155 and 201 feet, and is covered with gravel. On the boundary of Ballykeen and Drumacarney, Tamlaght-Finlagan parish, it varies in thickness from 2 to 22 feet; and it occurs in other streams, as well as in the boundary of Drumrane and Mullagh, near the Roe. In the townland of Moys it is elevated 340 feet, and equally so at Ballyderg, being 4 feet thick, and covered by gravelly clay. As the elevation increases the shells diminish; and in Bovevagh parish, boundary Ardinarive and Bovevagh they are scarcely discernible at an elevation of 450 feet, the bed being from 4 to 10 feet thick. In Drumachose parish, on the Castle river, the shells are scarce, and although calcareous clays may be found high up and even beyond the escarpment of the secondary rocks, the shells finally cease, and the beds are only characterized by their colour and pebbles. At Fruit Hill, fossiliferous clay was said to be found at the depth of 54 feet 8 inches, on sinking a well. On the boundary stream of Balteagh and Drumachose the arrangement of the detritus over the clay is 1·3 of earth, 4 of coarse gravel and sand, 3 of fine, 3 again of coarse, and then 3 of the clay; and innumerable cases of such alternations of the sand and gravel might be cited. In Balteagh, Little Derry townland, particles of shells are just visible; but on the boundary of Balteagh and Errigal, at an elevation of 663 feet, there are no shells. In Bovevagh, the most remarkable bed is on the Bovevagh river as it passes the old church; it is full of Turritella terebra, lying in all directions, and contains only fragments of any other shell; it is separated by a layer of gravel from a sandy calcareous clay not containing fossils, and that again is covered by a confused deposit of sand and gravel, 60 feet thick, streaked with more regular layers of sand and gravel. In Dungiven parish, on the Owenbeg river, and Gallany water it again occurs, containing its peculiar Nucula with chalk and flint pebbles, and covered with ordinary local detritus, including basalt.

This appears the extreme limit of the true tertiary clay as characterized by fossils, and it may be observed that, following a curve line round the primary schist margin into the parish of Dungiven, it has marked out the position of an ancient mud bank or banks, formed at a time when the sea was beating against and wearing away the chalk escarpment. That it is reasonable to assume this, has already been stated on the evidence afforded by the condition of the shells, the delicate Nucula being uninjured, as if deposited where it lived, though the strong Cyprina has been almost destroyed. The heaped up and confused arrangement of the Turritellæ, near the old church of Bovevagh, shows also a peculiar accumulation in that spot, the result probably of meeting currents, and in looking at the country, and mentally abstracting from it the superficial gravel, one is almost inclined to think that the course and manner of such formations can yet be traced.

Entering the parishes of Killelagh, Maghera, and Ballynascreen, examples of calcareous clay similarly related to the overlying gravel, and in some instances containing chalk pebbles are still met with, but there are now no shells. As these beds might be usefully applied as manure, in the districts where lime is scarce, the following localities are enumerated:—

Boundary of Killelagh and Maghera, highly calcareous; on the Fallagloon side, it is covered by a bed of red clay, beautifully laminated; and there are three other localities in Fallagloon, the clay in all being highly calcareous, containing chalk pebbles, and being covered either with other clay or with gravel of basalt and various primary rocks, including granite.

Brackaghreilly, on the boundary of Ballinascreen and Maghera parishes, south of the road to Derrynoyd.

Kilcronaghan parish, Drumcrow townland, south side of Moyola, under from 3 to 8 feet of very fine laminated clay.

Ballynascreen parish, townland of Strawmore, south side of Moyola, 11 ft. thick, with primary pebbles, covered with 15 ft. of sand and gravel, containing both primary and secondary pebbles, including chalk and flint; Gortnaskea stream, highly calcareous, with primary and chalk pebbles; south side of stream, Derrynoyd, capped by brick clay; and on the boundary of Derrynoyd and Cloane, capped by compressed sand; and lastly, in boundary of Desertmartin and Kilcronaghan, with numerous chalk and flint pebbles.

It is, of course, not demonstrable that these calcareous clays are identical with the beds containing shells; but their general aspect is much the same, and their relation to the wear of the chalk and basalt is also not improbable, similar beds not being found in Tyrone and Fermanagh, though calcareous clays, without basaltic and chalk pebbles, are not unfrequent.

Of other Clays.—The brick clay, so extensively spread out in the low grounds of Faughanvale and Tamlaght-Finlagan parishes, varying from 4 to 7 feet in thickness, cannot be associated with the former, but its exact geological position is not determinable. The progress, however, of such formations did not cease; and excavations on the flat, show the extent to which, in the most recent periods, they have been carried. In Tamlaght-Finlagan parish, townland of Broglasco, an excavation gave—

	ft.	in.	
1.—	3	6	Brown Clay.
2.—	1	0	Blue sandy Clay, and then shells.

Another east of the Ballykelly Canal—

	ft.	in.
1.—Earth . . .	0	6
2.—Fine Sand . . .	1	4
3.—Brown tenaceous Clay .	2	8
4.—Coarse Gravel . .	3	0
5.—Fine blue sandy Clay .	3	0
6.—Shells. The water rushing in.		

Hence there had been here an alternating deposit of gravel, sand, and clay, in all ten feet thick, deposited over the shells.

In Lower Culmore, one mile from the Lake shore, shells were found 4½ feet under the surface, and such examples might be multiplied; the shells being all recent and comparatively fresh, especially the muscles. In Dunboe parish, on the boundary of Grange (More and Beg), is a bed of blue silt full of recent shells, Mytilus, Turbo, &c., in the banks of the stream, covered by 7 ft. of fine sand (rabbit warren), the clay itself being 2 ft. 6 ins. thick, and also resting on fine sand. In Magilligan, formation has still further advanced by the aid of sand-drifts as the sand and bog alternate with each other on the banks of Lough Foyle; and a considerable way from it, in the townland of Aughil, an excavation penetrated to boggy sand, mixed with shells of the genus Lymnæa. In a similar manner near Portrush, on the west strand, a considerable quantity of hard flaky bog is laid bare by the waves, every storm breaking up a new portion; it is below the high-water mark, is covered by gravel and sand (rabbit warren), and contains leaves, nuts, portions of rotten wood, and the elytra of beetles.

But passing by these more recent results of the never-ceasing formative and modifying forces of nature, there are yet two deposits which have some claim to be placed in the tertiary formations. In Ballyscullion parish, close to Lough Beg, when the bog or detritus is penetrated, a stiff clay is found underlying it, bluish when wet, but becoming white by exposure; this is sometimes covered by irregular patches of blue clay 3 feet thick; and it is continued in the banks of the Moyola and Ballinderry rivers. It varies from 7 to 9 feet in thickness, rests on reddish sand, and is generally covered by sand from 2 to 9 feet thick. The clay frequently contains stumps and trunks of oaks, the former erect, the latter prostrate, and appears, therefore, of no very remote date; but in the townland of Mullan, the bank of the Ballinderry river exposes six feet of successive seams of sand and imperfect lignite, the latter in fragments, and arranged in thin layers of 1 to 4 inches thick. The sand rests on bluish stiff clay, and that on finely crystalline basalt; so that the relation between this deposit and the beds of lignite, clay, &c., of Washing Bay, Verner's Bridge, &c., already noticed in the review of Mr. Griffith's works (p. 74), is sufficiently strong to induce a belief that they are of the same age.

The other deposit is the remarkable accumulation of shells mixed with sand which occupies a bowl-shaped hollow, about 10 feet above the sea on the north side of Portrush, and open in that direction to the sea. It was first noticed by James Smith, Esq., of Jordan-hill, who has supplied the following list of shells, which he collected in his examination of it, to which may be added a rare zoophite, Caryophyllia Smithii:—

SHELLS,

From the elevated shelly deposit, Portrush.

Spirorbis granulatus.
——— sinistrorsus.
——— nautiloides.
Serpula vermicularis.
Vermilia triquetra.
Balanus rugosus.
——— balanoides.
——— communis.
——— punctatus.
Mya ferruginosa (Mont.)
Tellimya tenuis (Brown).
Anatina ovalis.
Mactra triangulata.
Saxicava rugosa.
Venus gallina.
——— ovata.
——— verrucosa.
Crassina Scotica.
Cardium elongatum.
——— nodosum.
——— edule.
——— exiguum.
Nucula margaritacea.
Arca pappilosa.
Mytilus edulis.
——— incurvatus.
Pecten distortus.
——— varius.
——— opercularis.
Anomia aculeata.
——— ephippium.
——— squamula.
——— undulata.
Terebratula cranium ?
Pectunculus glycimeris.
Odostomia spiralis.
Helix Trochilus.
——— crystallina.
——— nemoralis.
——— paludosa.
Clausilia rugosa.
——— biplicata.
Carychium minimum.
Pupa vertigo.
——— pigmæa.
Patella vulgata.
——— virginea.
——— pellucida.
——— cærulea.
Fissurella Græca.
Emarginula fissura.
Natica Alderi (Forbes).
——— glabrissima.
——— glaucina (young) ?
Trochus ziziphinus.
——— umbilicatus.
——— cinereus.
——— Magus.
Turbo littoreus.
——— rudis.
——— jugosus.
——— pullus.
——— retusus (Nerita littoralis).
——— canalis (Mont.)
——— subtruncatus (Mont.)
——— cingillus.
——— interruptus.
——— unifasciatus.
Pyramis discors (Brown).
——— striatus (Br.)
Cingula cimex.
——— alba.
Cerithium tuberculatum.
——— reticulatum.
Rissoa costata.
——— fallax N.S. (Brown) ?
——— Zetlandica.
Fusus septangularis.

Murex linearis (Mont.)
——— erinaceus
——— muricatus.
——— purpureus
——— adversus.
Purpura lapillus.
Buccinum macula.
——— reticulatum.
——— minimum.
Cypræa Europea.

Mr. Smith adds, " this shelly deposit seems to have been a sheltered bay into which the shells have been drifted, with a small admixture of land shells washed down by floods; none of the bivalves have both valves together, but they have been but little injured by the action of the sea; I never met with such a variety in so small a space, either in recent or ancient beds."

The shell-banks, or islands of Lough Foyle, though still covered by the sea at high-water, are naturally connected, as one link of a chain of events, with the preceding. They form, when the tide is out, extensive flats, which are firm enough to be walked upon without any inconvenience, and they are then resorted to by numerous boats for loads of shells; and though this system has been pursued for more than a century, they exhibit no appearance of a failure in the supply. The shells hitherto examined are all of recent species, and it becomes a question whence they came. Within Lough Foyle there does not appear any sufficiently extensive known habitat of molluscs to keep up such a constant renewal of the beds, 59,496 tons of sand and shells being removed annually; and if the shells are brought into the lake, through its narrow entrance, by the incoming tides, their original habitats are not yet fully discovered, though it is probable that a large portion are swept from the sea-sands of Magilligan and banks in advance of them, by the tidal wave moving in an E. and W. direction, and then hurried through the narrow opening into the Lough to be again spread out by the expanding wave. The case, however, is complicated: the sands of Magilligan, of the strand near Portstewart, and of the strands of Portrush are highly siliceous, the basaltic rocks having contributed comparatively little to them; hence it is probable that they have been principally brought from Ennishowen, and thus the phenomenon is of a double kind, the sands being first conveyed in one direction, and then carried with the shells in another; but it seems necessary to add to this mode of explanation one suggestion, namely, the possibility of some portion of the shells proceeding from a more ancient deposit, and to refer to the great abundance of Turritellæ which the banks supply, as a fact curiously analogous to the same accumulation of them in the tertiary clay of Bovevagh old church; the shells of the banks are, however, in a much more recent condition.

Henry Wiggins, Jun., Esq., has supplied the following details, practically illustrative of the extent of the deposit, and of its value to the country as manure:—

Boats of 8 tons and under, loading in one tide,	require	2 men
from 8 to 15 tons,	,,	3
from 15 to 30 tons, loading in two tides,	,,	3
from 30 to 45 tons, loading in from two to three tides,	,,	4
from 45 to 60 tons, loading in from three to four tides,	,,	5

The average wages of the men, 10*s.* per week.

There are 23 Boats under 8 tons, employing		46 men
32 from 8 to 18 tons,	,,	96
20 ,, 18 to 30 tons,	,,	60
12 ,, 30 to 45 tons,	,,	48
7 ,, 45 to 60 tons,	,,	35
Men employed		285
Besides boys at 1*s.* per day, say		50
		335 hands

Say 285 men, at 10*s.* per week, employed 26 weeks	£3,205
50 boys, at 6*s.* per week, ,, 26 weeks	390
Would make labour alone	£3,595

The aggregate tonnage of forty-eight of the largest Boats, is 1,306 tons; and lifting four loads per month, for six months, they raise 31,344 tons, which at 1*s.* per ton, is worth £1,567 4*s.*

The ninety-four Boats, raise 59,496 tons each summer, which at 1*s.* per ton, are worth £2,974 16*s.*

"This would make the sum paid for labour more than equal to the value of the shells procured, at 1*s.* per ton. But it must be remembered this is the price on the shore of Lough Foyle, immediately opposite the Shell Banks; and an extra price is charged for carriage at Derry and Strabane, bringing them up to 1*s.* 6*d.* to 2*s.* per ton, and more at particular times and seasons. Altogether the Shell Banks may be reckoned worth above £5,000 per annum to the country. The farmers frequently draw the shells seven miles inland, and to the top of Slieve Buck, and other high grounds. They are particularly useful in bringing bog lands into cultivation, and in ameliorating stiff wet clays deficient in calcareous matter, being applied at the rate of from 30 to 60 barrels per acre. They are preferred to lime, as warming and 'brittling' the land."

The several deposits which have been passed in review, may be arranged thus, beginning with the more ancient:—

TERTIARY CLAYS, NEWER PLIOCENE, } Containing, as a characteristic fossil, Nucula oblonga (Brown), common in the newer pliocene beds of the Clyde, but not satisfactorily known as a recent species.

This deposit appears to have a direct connexion as an ancient mud bank, with the wearing down of the chalk and basalt escarpment into re-entering angles or bays, and as it preserves its fossiliferous character from 100 to 300 feet above the present level of the sea, there must have been a rest of the ocean for a considerable period, at an elevation of probably 400 feet above its present level. The basaltic pebbles which the clay contains, prove that it was deposited after the pouring out of the volcanic traps; hence the basalt is anterior to the newer pliocene, and the lignite alternating with it has proceeded from plants of an earlier period of the tertiary strata.

2. The clays and sands, with lignites, on Lough Neagh and Lough Beg, were of lacustrine origin, proving a former level of those Loughs from ten to thirty feet higher than the present. The trunks and stems of trees found in the clay must either have been drifted and sunk into the soft mud, or have been silted up with mud after their destruction, which would imply a successive rise and fall of the Lake. The exact relation of these beds to the gravel hills and ridges, which are so remarkable in the parishes bordering the Bann on the west, cannot perhaps at present be determined, although the upper beds are probably, in some cases, posterior to portions of them, and therefore of far more recent origin than the Nucula clays. It is not improbable that their date is intermediate between the Nucula clay and the Portrush shelly deposit; the latter marking a rest of the ocean at about 15 feet above its actual level in the present zoological period.

3. The recent shell-beds of the flats of Myroe, &c., in which the shells preserve their colour and lustre, approximate to the present times, and prove a steady continuance of the formative

and elevating processes which are so distinctly traceable in all geological systems; and this is further seen in the successive steps or flats of sand and gravel formed by the detritus along the shore of Lough Foyle, as well as in the interior of the country.

4. Modifications of the coast line have opened new channels for the drift sand, which has inundated the low ground, and covered boggy flats with hills of sand.

5. The shell-banks of Lough Foyle are of an intermediate character, having probably commenced prior to the two last, although they are still in a course of renewed formation.

Finally. It may be remarked, that the clays of No. 2, and also beds like those of Faughanvale, Tamlaght-Finlagan, Kildress in Tyrone, &c., which overlie them, are extensively used for bricks and coarse pottery; that the farmer may readily discover the calcareous clays belonging to the 1st division by the distinct line of demarcation, on the banks of streams, between them and the super-imposed gravel; and that submarine peats, such as that of Portrush strand, have lately been used as manure with great advantage. On this last subject the Rev. J. V. Vincent writes:—

> "On the sea coast of Carnarvonshire, in several places, about two feet beneath the surface of the sand, and below high-water mark, there is a decayed vegetable deposit, or turbary, of the thickness of from four to five feet, strongly impregnated with sea salt. Of this I have been for several years in the habit of making a compost, such as was recommended by Lord Meadowbank, by mixing it with fresh dung. In a few days after incorporation, a very strong heat is produced; and as soon as the fermentation began to diminish, I have had it carried on the turnip land, and it has proved invariably as effective as an equal quantity of rotten dung. Last year, having seen an account of the advantage derived from the admixture of lime and salt as a manure, I thought this saline turbary, if mixed with lime, might be equally beneficial. I accordingly caused seven cart-loads to be carried from the shore into a bed, and when well pulverized, it was thrown into a heap, and mixed with a cart load of coal ashes: during the operation about a barrel of soap-suds was poured upon the heap. I then procured a cart load of quick-lime, and, having reduced it to powder with water, it was thrown into another part of the shed. The two heaps having remained separate for a month, and each being quite cold, they were then well mixed together. In three or four days the compost became as hot as a dunghill, a strong fermentation taking place: it was allowed

to remain in this state for a few days longer, when, the heat beginning to decrease, it was carried into a field preparing for turnips, and spread in the drills in the same manner as bone-dust. The crop proved a very good one, from 30 to 35 tons per acre, and was considerably superior to those manured with bone-dust, the year before, on land of better quality. Although there may not be many localities which afford this sub-marine turbary, there are several in which turbary abounds, and which, with the addition of lime and salt, may be turned to good account. The land on which the compost has been used is rather light—the subsoil in one instance gravelly, in another a mixture of clay and gravel, with a considerable portion of oxide of iron."—*Journal of the Royal Agricultural Society of England*, vol. 2, p. 417.

NOTE.

In the Appendix to the Second Report of the Railway Commissioners, page 22, Mr. Griffith observes, "In the parish of Clonoe, in the County of Tyrone, the clay beds rest on the new red sandstone, which overlies the coal formation of Coal Island; and during the last ten years several trials were made by boring in the clay district, in the expectation of finding the coal beneath it. Two of these trials in the townland of Anaghmore, were continued to the depth of 294 feet, without reaching the red sandstone; and several other trials were made in different parts of the district, with the same results. The elevation of the surface at Anaghmore is 110 feet above the level of the sea, and 62 feet above the level of Lough Neagh; and, consequently, it becomes evident that the bottom of this tertiary deposit must be at least 184 feet below the level of the sea." This is an interesting fact, as regards both the elevation of the upper surface of the deposit and the depression of the lower surface, as well as the extraordinary removal of the new red sandstone and the subjacent strata which it indicates. If indeed the whole 294 feet of boring were actually in the tertiary clay, the basin of Lough Neagh must have been vastly deeper than its present extreme depth (100 feet), and received, therefore, an amount of detritus equivalent to a thickness of 100 feet over probably a space of 300 square miles. If, however, these borings were in advance of the outcrop of the new red sandstone, may not some of the borings have penetrated to the clays of the lias, or even to the marls of the sandstone? Mr. Griffith gives also the following details of a boring made at Sandy Bay:—

	ft.	in.
Blue Clay,	10	0
Black Lignite, mixed with Clay,	25	0
Clay,	2	6
Black Lignite,	20	0
Clay,	4	0
Black Lignite,	15	0
Total,	76	6

a thickness of this curious deposit which is very remarkable.

CHAPTER VII.

CRYSTALLINE SCHISTS—GNEISS—MICA SCHIST—HORNBLENDIC SCHIST.

No. 20.

THESE rocks, remarkable at once for their great extent and for the variety of their mineral character, are, without doubt, in the north of Ireland and Scotland, anterior in formation to the secondary strata, as in some one or other portion of their area, they are found to underlie them all: hence they may be assumed as the base of the stratified rocks in this district. Following their outline on the Map, it is found to be very irregular, exhibiting deep bay-like indentations: and if the portions which actually crop out were alone taken into consideration, it would become even more so. The strata have, therefore, been exposed to very great forces of degradation, and suffered extensive denudation prior to the deposition of the secondary strata, which penetrate into and occupy all the vacant spaces. On the north of Derry, in Faughanvale and Tamlaght-Finlagan parishes, this is very distinctly marked, and the manner in which the sandstones penetrate into the recesses of the schist and cover over its edges is well seen in Coolagh river (Pl. C. fig. 3); it is exhibited on a larger scale in Dungiven parish, and again in the valley of the Moyola. Without doubt the strike of the strata, being in an E. and W. direction, has contributed to produce or augment this effect; but alone it would not account for the sinking of the strata eastward in Balteagh parish, where their edges break out in the low ground, and testify to the great wear they have experienced. And again a very striking example of the great changes which have taken place is afforded by the detached tract of mica schist, running nearly N. and S. from Ballynascreen parish into Errigal, and skirting Dungiven and Killelagh. To represent this isolated strip as the result of a local elevation alone would be quite erroneous, as there can be little doubt that the portion of schist close to the junction of the Feeny and Dungiven roads from Draperstown is continued under the secondary rocks till it joins the corresponding strata of Coolnasillagh (1371 feet); the wear therefore at that point must have been very great, and it has left a dividing ridge under the sandstones, along which there is a tendency to fracture in the overlying beds (Pl. E. fig. 2.) Considering, then, the mica schist, extensive as it is, as only a portion of a much greater whole—being continued in Tyrone and Donegal on the one side, and Antrim and Scotland on the other—the amount of wear must have been enormous, far exceeding the denudation of the secondary strata. The winding line already referred to as the eastern boundary of the schists in this district (with the exception of the detached portion of Coolnasillagh lying beyond it), may be readily traced from Templemore parish by Faughanvale, Tamlaght-Finlagan, Drumachose, Balteagh, Bovevagh, Banagher, Dungiven, Ballynascreen, where it terminates at the metamorphic belt of Slieve Gallion. Westward, it is continued into the Counties of Tyrone and Donegal, some small patches rising up at the Fir Mountain, amidst the metamorphic rocks, S.W. of Lough Fea; and this fact is deserving of special attention, as the schists have evidently undergone extensive change, having almost lost their laminar structure, and merging, therefore, into the metamorphic greenstone.

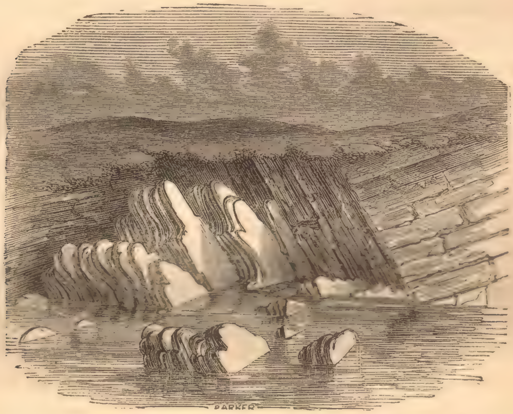
In a former account of these schists (Memoir of Londonderry), it was attempted to classify them, in a simple manner, according to the mineral which prevailed in their composition, and to connect the variety observed with some peculiarity in their original composition. Hence, mica slate passing into clay slate was considered to represent a period when clay or mud had prevailed; mica slate passing into quartz slate one in which sand, or probably silica under some other condition, abounded: mica slate passing into gneiss, gneiss, mica slate passing into granite, &c., those modifications which may have resulted from the increased intensity of metamorphic action; and finally, the various hornblendic strata which sometimes alternating with the schists appear to have passed through the same species of modification, only exhibiting a different metamorphic result in consequence of some peculiarity of composition, and at other times exhibit all the characteristics of fused or igneous rocks. The presence or absence of lime may have possibly contributed to produce some of these varied results; and it is certainly remarkable that many of the hornblendic protrusions, are in immediate connexion with crystalline limestone; and that lime is even yet detected by a faint effervescence in the metamorphic hornblendic rocks of Slieve Gallion, of which some portions are little more than coarse gritty serpentines. There seems to be no reason for doubting the accuracy of these principles; but in respect to the original extension of each member of this compound formation, and its place in order of super-position, the limitation of inquiry must render the account here given imperfect.

In Templemore, Faughanvale, and Clondermot, the clay-slate variety is most abundant; and taking the average direction of the strike into consideration, it would correspond to the slates of Letterkenny in Donegal; but the line passing north of Antrim, the clay-slates are not there found. The quartz-slate variety occupies a large portion of Faughanvale, Clondermot, Lower and Upper Cumber; Legavennon, Slieve Buck, Slieve Kirk, Crook Dooish, &c., being all of this variety; but though this distinction is drawn as to the region of peculiar abundance, this and the preceding variety alternate with each other in many localities, and also run into the more granitiform varieties. In respect to dip it is generally a little west of north, and in amount variable but usually great, 40° to 60°; here, however, a caution is necessary, as it is somewhat remarkable that though in all the clay-slate varieties the dip, when taken on their faces, is great, it is much diminished when outcrops of the more quartzose beds are examined, and it is, therefore, evident, that the true vertical thickness of the strata cannot be determined by a mere line of sections; and it is even probable that the strata were arranged in a curved or domed form.

Proceeding southward, the rocks become more granitiform, and the mica schist often passes into gneiss, and sometimes can scarcely be distinguished from a fine-grained granite; both the preceding varieties, however, still alternating with the others, though in a diminished degree. This is the prevailing character of the rocks in Banagher, Dungiven, and in the detached tract of Coolnasillagh, embracing the mountain district of Doon, Muinard, Sawel, &c. The dip is here very irregular, turning more to the east, and by its frequent changes showing contortions and manifesting great internal movements. These strata appear to correspond with those of Antrim and of the south of Donegal, garnets occurring in the schist of Antrim, in abundance in Donegal near the Fermanagh boundary, and more rarely in Derry. They also contain schorl. The portion of the schists, near Ballyshannon, has been specially separated by Mr. Griffith from the mica-slates as mica-slate passing into gneiss; but it does not appear to offer any marked peculiarity, by which it could be distinguished from some of the more gneissose varieties of other districts.

Hornblendic Rocks.—Associated with the schists are hornblendic rocks of various kinds; some being either smooth and uniform schists, like flinty slate, or distinctly compound as greenstone, and others so massive and crystalline as to have all the characters of distinct igneous rocks. They are not confined to any part of the system; but they are much more extensively developed in the lower or gneissose portion than in the upper or slaty portion, and are very often connected with deposits of limestone. A fine example of this connexion is seen on the Faughan river, at the quarry of Drumahoe near Ashbrook, parish of Clondermot. A large bed of limestone is succeeded by the ordinary clay-slate variety of the schists, then, 12 feet of hard quartzose hornblendic schist, like flinty slate, 24 feet of apparently indurated schists, 50 of greenstone, 12 of indurated or altered schist, 55 of crystalline greenstone; the portions which by retaining so much of their laminar character are here classed as indurated or altered schists, are extremely dense, having a specific gravity of 3·15. The beds are much contorted, and their eroded edges by unequal wear, produce a riband-like appearance of the strata, which is extremely curious, as they cross the bed of the river.

No. 21.



The same rock occurs again in this parish at Clappernow, and at Lisneal, and it is difficult to account for such alternations, and such fusion of one stratum into the other; and especially for so high a specific gravity which seems to imply a condensation or contraction of the whole mass in the process of metamorphism. Similar combinations of these rocks with the schists and limestones, occur on the river Roe above Dungiven, and are finely marked near the old church; the limestones are also highly crystalline, the crystals large and dark-coloured, a very beautiful variety. Above Banagher church, hornblendic rocks of various kinds occur in the schist, sometimes very slaty in structure, at others more massive; and such alternations continue westward to the limits of the County. The most remarkable, however, of all these combinations of igneous, metamorphic, and unaltered rocks, is exhibited in the Glenrandal river in Upper Cumber. The schists, in ascending this stream, are found to be much indurated, and are associated with limestone and greenstone rocks; the greenstone is so highly charged with iron as to disintegrate into extensive beds of a very rich ochre. The ochre is sometimes in the state of a hydrate and yellow, and at other times red. The mode of alternation is—felspathic mica schist, or gneiss, compact below, but quite rotten and decomposed at top; ochre, graduating into a decomposing greenstone; gneiss, or felspathic mica schist, most decomposed at its junction with the greenstone or ochre. The greenstone also occurs within the ochre, and by its decomposition gradually merges into it. It is difficult, from the winding of the river and the great wear of these soft beds, to determine the number of alternations, or the correct thickness of the beds; but it is probable that there is one very extensive bed and one or two of less thickness, which traverse the schists in an oblique direction, the dip of the strata being much modified in their vicinity. In a branch stream to the west the ochre is met with, alternating with less altered greenstone, the total thickness of the greenstone being 26 feet and of the ochre 18 feet, or together 44. And in the townland of Aughlish, in Banagher, it is upwards of 50 feet thick; several patches of greenstone within the mass being still solid and merging into the ochre. It occurs also in Tamnagh townland, parish of Banagher; and again in Glenviggan townland, parish of Ballinascreen, on the boundary of the Counties of Tyrone and Derry, a bed is seen from 3 to 8 feet thick, associated with black schist, hard quartzose-schist, and greenstone, a seam of decomposed felspathic rock occurring here also.

This deposit is one of considerable economic value, as the ochre is in a condition very suitable for practical application. On the surfaces of cleavage it is often quite black, but when broken the inside is of a fine yellow. It readily crumbles down so that the expense of working it would be trifling; and when roasted it assumes a very fine red colour. As an ochre, it is very rich in oxide of iron, and it will be interesting to compare the following analysis of it with Dr. Apjohn's analysis of the Drumrankin ochre found by Mr. John M'Arthur near Ballymena, in the County of Antrim, and forming part of the basaltic system described in Chapter V.

OCHRE OF THE SCHISTS ANALYZED BY CAPTAIN PORTLOCK.

Soluble Portion.		
Per ox. Iron	24·48	
Alumina	8·73	
Trace of Magnesia, Lime, and Silica		33·21
Insoluble Portion.		
Silex	37·35	
Alum	8·21	
Per ox. Iron	8·44	
Trace of Lime		54·00
Water		13·90
		101·11
Or considering the Iron in the insoluble portion as a Prot-ox.		100·27

OCHRE OF THE BASALT ANALYZED BY DR. APJOHN.

Silex	56·40
Alumina	3·46
Per ox. Iron	24·14
Carbonate of Lime	0·90
Water	15·10
	100

"The silex of the basaltic ochre is at present in a state of extreme division, and from this circumstance, and the great depth and beauty of its colour, it appears well suited to the purposes of a red paint for gates, railing, and other descriptions of out-door work."—(Dr. Apjohn.)—*Journal, Geol. Society of Dublin*, vol. 2, p. 140.

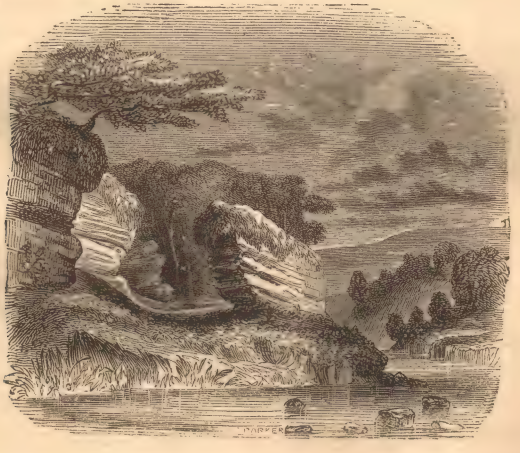
For painting carts and wood-work of all kinds, this ochre would be very useful. Berzelius remarks, "in Sweden, it is employed as a red paint for houses built of wood, which it preserves." It might be also used, when properly prepared by trituration and levigation, as a polishing powder. The simplest mode of operating upon it would be to lay troughs along the stream, connected at intervals with wooden cases or reservoirs, and breaking down the lumps, to throw the fragments into the troughs and admit a small current of water from the river into them; they would then be hurried along, and ultimately in some one or other of the reservoirs be found in the state of a fine paste or powder, which dried and roasted could be readily transported into Tyrone or Derry. The beds thus described, from the abundance of their iron, indicate a great divergence in character from the ordinary hornblendic schists, and in this respect exhibit an analogical resemblance to the ochreous beds of the basalt, and taking into consideration the great variety of the hornblendic rocks, some being slaty others massive, some almost granular others highly crystalline, some calcareous, and so forth, it seems reasonable to believe that, in the same manner as metamorphic are probably associated with erupted rocks in the basaltic field, so here also similar phenomena are exhibited, crystalline erupted or fused hornblendic rocks having been protruded amongst metamorphic quartzose and hornblendic schists, and streams of volcanic mud poured out amidst the schists and with them subjected to subsequent metamorphic agency.—(*See also Note at the end of Chapter.*)

It is deserving of remark that whilst quartz veins are abundant in many parts of the schistose country, no decided metallic lode has yet been discovered, though fragments of galena have been noticed in limestone, and also picked up in the detritus. And again, with so many examples of hornblendic rocks there are few true dikes; whereas the old red sandstone of Tyrone and Fermanagh is penetrated by numerous dikes, and the other secondary strata also afford examples of them. Do not these peculiarities point to some peculiarity in the metamorphic processes, something more analogous to the hypogene theory of Lyell than to that of eruptive rocks.

Limestone.—The manner in which lime has entered into the composition of the schistose rocks is very instructive; it is often found in the finer or more slaty species, arranged in thin laminæ, or it appears in thick and extensive beds; and connecting together these two conditions, it seems demonstrable that the lime was originally deposited in alternating beds with clay or mud, just as in the shales and limestones of the carboniferous period; the degree of alteration of the one corresponding in many respects with that of the other: as the limestone attains its highest state of crystallization in the gneissose portions of the system. The principal deposits of this valuable rock are in Bond's Glen, partly in Lower and partly in Upper Cumber, where it may be traced for 2½ miles in a distinct valley of stratification; three beds, divided by rotten schists, and in thickness amounting to 20 feet, have been worked, and a fourth has not yet been touched upon. In Altaghoney, Upper Cumber, it is extensively developed in beds parallel to the preceding, and has been much used for tomb-stones, &c. In the parishes of Banagher and Dungiven it is also found in considerable quantity, being generally associated with hornblendic rocks, which also are occasionally calcareous. Lesser layers of limestone and schistose rocks slightly calcareous, are to be found in all parts of the system; that of Prehen, near Derry, having been somewhat more extensive; but these will be more advantageously set forth in a simple list of localities. Bearing in mind the prevalence of lime in the schistose deposits, and the frequent association of the limestone with trap rocks, it will be easy to comprehend the nature of the great mass of metamorphic schist of Slieve Gallion, which is still in some places calcareous, whilst in others it approximates closely to true greenstones.

In respect to the accidents which have affected the strata, little more need be said than has already been urged in respect to wear and denudation. The Gap of Spelhoagh is a fine example of wear, and is an enlarged representation of the Pot of Leganannim (see page 148); a small stream still pursuing its course through the ravine. Some of the waterfalls, such as the beautiful Lugnapeiste; and still more strikingly the passage through the Ballydoonan Rocks, in Banagher parish, indicate fracture or rending of the strata, as well as ordinary wear. And in other cases, the streams follow a very devious course, first along the troughs of the strata, and then dropping transversely from one to the other. In that of the Burnthollet, where the water flows in the direction of the strike and descends at the Ness (see Wood-cut, No. 20,) by leaps down the faces of cleavage, dislocations must have assisted; and the place itself is further interesting as affording a beautiful example of an ancient river-course now abandoned by the stream, and ten feet above its level.

No. 22.



It has the appearance of an avenue between rocks, those next the river being large irregular masses covered with small trees and shrubs.

No. 23.

Many other examples of dislocation of the strata, and of wear by rivers or streams in their former condition, might be cited; such as the very striking insulated rock or hill in Bond's Glen, another of the same kind at the west end of Altmover Glen, and the rocky bluff of the Oaks; but it is impossible to wander anywhere, with a geological spirit as a guide, without seeing at every step illustrations of the never-ceasing action of such modifying forces. The actual interior of the great mass of the schist is not seen; but from the existence, in some cases, of quartzose beds, as, for example, on the side of Slieve Kirk, not agreeing in arrangement with the more superficial beds, all being regular without, but not equally so within, it is most probable that these rocks have undergone a much greater degree of change within their mass than is seen at the surface.

In illustration of these general remarks, the specimens of the whole district have been carefully examined, and the result is given by Sheets and Numbers, as the best means of showing the remarkable variety which exists in such formations, and enabling any one to study them to advantage, the Sheets being arranged for this purpose from west to east, in order to follow out the lateral extension of the several varieties of the schist, according to the principles already stated.

In respect to the mutual relations of these rocks to each other, and the modification of their ultimate condition, which may have resulted from a difference of original composition, it will be useful to inquire into their constituents. One of the most remarkable is the rock noticed at page 191, amongst rocks of a hornblendic character, No. 46, 45, 78, &c., which, though externally resembling such rocks, has a distinct affinity to the quartz rock variety of the schists. Comparing the latter with one of the rocks of a greenstone type in its principal constituents, though of course neither can be expected to preserve a uniform composition, the results are :—

Quartz Rock variety, supposed coloured by Chlorite.		*Rock of a Greenstone type.*	
Silica	48·81	Silica	51·49
Alumina	12·58	Alumina	13·59
Prot. ox. Iron	25·64	Prot. ox. Iron	18·47
Lime	8·81	Lime	10·20
Water	1·27	Water	1·24
	97·11		94·99
Magnesia and Alkali	2·89	Magnesia and Alkali	5·01

The great difference here is in the excess of iron in the chloritic quartz rock, corresponding to the constitution of that mineral, and in the greater amount of magnesia and alkali in the greenstone-like rocks; and it is easy to see how readily variations in the mineral proportions of the original deposits may have tended to produce, under the operation of metamorphic agencies, the extraordinary variety now observed in these rocks, embracing as it does every shade of change, from clay-slate to rocks of a greenstone type though still preserving their bedded character. It is further deserving of notice, that these rocks, though examined in sound specimens, are found to be constituted of two portions, an insoluble or undecomposed portion, and a soluble or decomposed portion. The decomposed portion consisting of alumina and per-oxide of iron, which, on heating, causes a change of colour in the powder of the rock, from grey to light brown; and it is the gradual progress of this decomposition which has produced the beds of ochre before described. In respect to the other, or more decided schistose rocks, the quartz-slate, a prevailing variety, is remarkable for the deficiency of lime, which leads to a similar deficiency in the greater portion of the soils of Derry, as will be further pointed out in the Chapter on Economic Geology, and for an excess of silica.

Quartz-slate.		*Clay-slate, not of the most perfect variety.*	
Silica	67·02	Silica	52·45
Alumina	14·92	Alumina	12·01
Per-ox. Iron	11·36	Per-ox. Iron	17·92
Lime	0 73	Lime	7·72
Water	2·41	Water	6·08
Magnesia, Alkali, and loss	3·56	Magnesia, Alkali, and loss	3.82

Between rocks closely resembling clay-slates, with laminar structure and shining appearance, and rocks by external appearance associated with greenstones, there would appear to be little affinity,—and yet the composition as regards the principal universal constituents is, as may be seen, by no means so varied as might be supposed—the silica, the alumina, the iron, and the lime, not differing more than is often found to be the case in varieties of the same mineral; a very small alteration or addition of substance is therefore sufficient to place a rock in such a condition as may lead to a most important ultimate change; and viewed in this light, the varieties of the schists, as shown by the detailed description, possess a very high geological interest.

The cleavages in the schists are by no means constant in direction, nor regular as to the angle of their planes with the horizon, as may be judged from the following examples, taken entirely from the northern portion of the schists, in which the dips of the stratification are more uniform than in the southern, or more gneissose portion :—

Near Prehen,	Dips to N. 18° W.—55°	Cleavage, plane dips, to S. 18° E.—48°
Kildoagh Quarry,	N. 18° W.—27°	,, ,, N. 8° W.—65°
		2nd do. ,, S. 18° E.—60° This is a clay-slate quarry, and the true stratification becomes doubtful.
Solus,	N. 13° W.—48°	Cleavage, plane dips to S. 38° E.—55°
Quarry above pottery, Muff,	N. 16° W.—64°	,, ,, S. 9° W.—57° And another in vertical plane.
Quarry near Seminary,	N. 13° W.—45°	Cleavage, plane dips to S. 70° W.—60°
Near junction of Glenrandal with Faughan,		,, ,, S. 71° E.—82°

It would appear, therefore, that the schists are divided by the cleavages into irregular prismatic masses.

Keeping the preceding results in view, numerous illustrations will be found in the following details, of the close affinity of the more massive schists to rocks of a distinctly igneous type, and of the transitions which may with ease have been effected between them. The numbers being also taken from west to east, cannot be arranged in distinct succession; their irregularity is therefore unavoidable.

As a whole, the rocks are quartzose, containing a large amount of quartz, and having a tendency to a gneissose structure, especially in the southern portion of the district. The mica generally is black or dark brown and brilliant ; often of a rust colour. The quartz is yellowish-white, semi-granular, granular, or compact, while the felspar, when it occurs, is either reddish and of a crystalline structure, or yellowish-white, and then granular. Chlorite, varying from dark green to light apple-green and yellowish, in colour, occurs in small scales. Throughout the district there is a remarkable absence of most of the minerals which so commonly accompany similar rocks ; thus garnet can only be traced in a very few instances, and then only in minute quantities; it is more frequent in Antrim, and is locally abundant in Donegal. Schorl is abundant in some portions of the lower schists ; it occurs in slender, acicular, and aggregated crystals, generally arranged on the laminæ of the schists ; but sometimes also crossing them, and frequently much curved. It is invariably found, where the schists become talcose, and only occurs in quantity, where the rocks are also crystalline, or semi-crystalline.

1. In the lower, or gneissose portion of the schists, the rocks are principally compounds of quartz and mica. The mica is dark or black, and in a very few instances in crystals; the felspar is similarly crystalline, whilst the quartz rarely presents even an internal crystalline structure. The mica is not merely arranged in continuous sheets, forming partings in the rock, but occurs also more equally disseminated throughout it, the rocks becoming more massive and less schistose. Where chloritic or talcose varieties occur they are invariably accompanied by crystalline felspar, and crystals of schorl, which lie on and across the laminæ, and are frequently curved round the felspar or quartz lumps. The micaceous varieties are, from the prevalence of this ingredient, of a darker colour than usual ; the mica is brilliantly metallic in lustre, and where continuous in partings, the schist assumes the character of a "shining slate." The quartz laminæ are less regular and more lumpy, giving a peculiar unevenness to the fracture. Felspar, in small quantities, is common, and the rocks have a prevailing gneissose structure. Curved lamination is not uncommon,—sometimes on the large scale, but frequently the curvatures are very small, and beautifully seen in hand specimens.

Granitic veins of quartz, felspar, and chlorite or mica, are more common than in the upper members. Iron pyrites generally accompanies them in small quantities.

2. In the second member, mica schist passing into quartz schist, the rocks are generally more schistose ; quartz rock, or that variety of micaceous schist in which the quartz forms thick layers, while the mica, in thin and almost evanescent partings, is only visible in the longitudinal

fracture, is of more common occurrence; a bluish colour is not uncommon in the rocks of this division, occurring chiefly in those which contain lime, or are associated with limestones. There is also a great prevalence of hornblendic or metamorphic rocks, in some cases slaty, in others more crystalline and greenstone-like, while others again are chloritic and soft. The limestone presents but very slight variations from its general character; it is almost invariably micaceous, always crystalline or semi-crystalline; the mica generally occurs in flakes, which renders the limestone schistose; in colour it is of a deep bluish-grey, lighter varieties being seldom met with; veins and strings of pure white massive carbonate are common, frequently shooting into crystals of many forms. Iron pyrites is an almost universal ingredient, occurring, for the most part, in minute disseminated crystalline grains, but also as crystalline coatings on the fissures. Lead glance is also occasionally, but not frequently met with, in small masses, imbedded in the concretionary veins of the pure carbonate. In a few localities, the limestone, instead of the ordinary blue colour, is of a greenish or olive green colour, probably from admixture of serpentine. In other cases it is of a largely and highly crystalline texture, and of a very dark grey colour, a variety which is well marked at Dungiven old church, in the river, Sheet 31, No. 435. It also occurs in part of Banagher parish, Templemoyle townland, Sheet 30, No. 7. Precisely similar limestone, so identical that hand specimens from the two localities could not be distinguished, occurs in the County of Antrim, at Tor Head, stated to be in mica slate. This primary limestone, by the increase of dark clayey micaceous matter, passes into a variety of shining clayey schist, on the one side; and by the assumption of siliceous matter, into a very hard bluish quartz-slate, with calcareous matter disseminated.

The hornblendic rocks are of two varieties; one in which the ingredients are crystalline, and have a truly crystalline arrangement; the other, in which, though crystalline in themselves, they are arranged in parallel planes, or are rudely laminated, thus giving the rock a semi-schistose structure. The first variety is comparatively of rare occurrence, (confined chiefly to Sheet 29.) It varies from large to fine grained, and closely aggregated; in some the felspar is white, or whitish, affording a rich contrast to the dark green hornblende, while in others it is green, and then the rock is generally finely crystalline; quartz also occurs as an ingredient, the rock thus passing into a syenitic greenstone; again, hornblende alone, or nearly so, forms the rock. Iron pyrites in minute grains is common; and it also occurs forming thin coatings on the fissures; small patches of mica, of dark bronze colour, are not unfrequently imbedded, or it occurs in minute disseminated scales.

The second variety is composed, for the most part, of whitish felspar and hornblende, the latter fibrous; the ingredients are rudely crystallized, and are arranged parallel to the planes, thus giving the rock a roughly fibrous longitudinal fracture. In others the hornblende forms the larger portion of the rock, imbedded in which are prismatic crystalline portions of felspar, having a somewhat stringy arrangement. Similar rocks also occur, having thin, scarcely discernible partings of mica, which give the rock a schistose fracture, in addition to the fibrous texture produced by the nature and arrangement of the ingredients.

In all these rocks, the ingredients do not appear to be truly crystalline, but only to possess internal crystalline structure, visible on the cross fracture.

Independently of these hornblendic rocks, there are others, which, having very much the external character of primitive greenstone, appear to be solely a finely granular and dense quartz rock (See page 178), of green colour, probably from admixture of chlorite or of hornblende, which also occurs as thin, almost evanescent partings; iron pyrites abundantly disseminated in very minute grains; carbonate of lime both admixed and in veins on the fissures.

This member of the series occurs more particularly in the southern portions of Sheets 22 and 23—the northern portions of 28 and 29. 30, 31, 26, and part of 32, and the N. W. corner of 34.

The third member of the schists, mica schist passing into clay-slate, extending from the northern boundary of the preceding, to Lough Foyle, is remarkable for the comparative deficiency of mica, chlorite, in many instances, supplying its place. Coarse gneissose rocks occur, which are hard compounds of felspar and quartz, having, in many cases, a very conglomeritic aspect. The quartzose slates are softer, have a prevailing greenish colour, and are sandy in aspect. Clay-slate beds are sufficiently numerous to affect the general character of the district; in the lower portion of this class, quartz rock or quartz-slate is not unfrequent; in the upper, several thin beds of pure talc-slate. Limestone is not abundant, occurring only in a few detached patches. Curved lamination is frequent; veins of a very marked character are not numerous; irregular seams of massive quartz. The mica of the quartzose kinds commonly white, and in minute scales. The rocks are very frequently much coloured by per-oxide of iron, which occurs in patches, coating the fissures, and colouring the partings. Schorl in minute acicular crystals, but not common.

The general character of each division being thus noted, it remains to mark very briefly the several minute varieties which appear more local and confined. This will be done by Sheets arranged from west to east.

Sheet 9.—*Rocks generally quartzose, few clay-slate beds.*

27. Much iron-shot—small grains of quartz imbedded. 25. Very quartzose—laminæ curved and irregular—cubical crystals of pyrites. 11, 15. Irregularly laminated—numerous lumps of quartz, sandy. 16. Do. do., more compact. 7. Coarse irregular laminæ, many oval lumps of quartz and felspar. 28. Red from oxide of iron, slightly conglomeritic. 46. Semi-crystalline, with crystals of carbonate of lime. 45. Do., finer grained, thin crystalline coatings of carbonate of lime on cleavages. 44. Curious rock, of a dark bluish colour; contains numerous portions of glassy, white, and bluish quartz, of carbonate of lime, of felspar, and of iron pyrites; the cement is a micaceous uncrystalline paste. 40. Do., more chloritic and slaty, with small plates of carbonate of lime. 5, 12, 26. Slightly gneissose: seams of quartz. 14, 24. Laminæ thin and irregular, pyrites imbedded and on the cleavages. 19, 39. Very quartzose, chloritic, greenish. 6, 9. Do., quartz veins. 8. Mica, in thin laminæ. 10. Lamination irregular and curved, mica bright. 17. Slightly crystalline. 22. Laminæ curved and thin, mica earthy, and in thin partings. 21. Do., veins of quartz, and carbonate of lime. 30, 31. Irregular layers of quartz. 4, 10, 13. Nearly intermediate between the quartz and clay-slate varieties. A vein of crystalline quartz, felspar and chlorite, with carbonate of lime and iron pyrites, at No. 25.

Sheet 14.—*All the specimens from this Sheet are varieties of the quartz-slate, and have a green tint, probably from admixture of chlorite.*

9. Talcose. 2, 13. Very quartzose, mica only in thin shining coatings. 3, 8. Thinly laminated, soft, and chloritic, 6. Do., slightly felspathic. 4, 11. Do., more quartzose. 12. Quartzose and chloritic, with coatings of carbonate of lime. 5. Greenish quartz rock, with occasional appearance of mica. 10. Limestone very schistose.

Sheet 15.—*The rocks of this sheet have an argillaceous aspect, and are of a greenish hue; thin veins and strings of quartz accompany the variety intermediate between the quartz and clay-slates.*

23, 27. Coarse gneissose, but distinctly laminar. 33. Do., much iron-shot. 83, 90. Very coarse. 51, 55. Coarse, shining talcose mica on the partings, small lumps of red felspar. 25. Similar, but not so coarse. 91. Talcose. 93. Soft chloritic gneissose. 41. Laminæ much curved. 43, 51. Do., finer grained. 121. Slightly gneissose. 22, 116. Laminar do. 92. Light sandy quartz, with many imbedded small lumps. 45. Syenitic gneissose, mica forms thin partings. 72, 87. Rocks precisely similar to that at Sheet 9, No 44, calcareous, conglomeritic, and gneissose, with numerous lumps of quartz and reddish felspar imbedded, semi-crystalline. 95. Slightly gneissose. 112, 99, 42, 21, 72, 106, 48. Mica only in thin shining coatings. 73, 104. Green do., pyrites. 36. Chloritic, dark green. 63. Very quartzose, coloured by iron. 46. Mica only in thin partings, with small lumps of quartz. 47. Do., laminæ curved. 82. Do., green. 88. Very quartzose. 103. Laminæ thin and curved. 29. Do., chloritic. 112. Do., coarse. 63. Of the ordinary quartz-slate character. 28, 86, 90. Quartzose do. 20. Do., with coatings of carbonate of lime on the cleavages.

109. With veins of quartz. 38, 94. Green granular quartz rock. 39. Do., with mica. 118. Greenish and very quartzose. 117. Do., mica forms thin partings. 107. Clayey, and with quartz in irregular seams or layers. 108. Dark blue, clayey, coarse. 20. Talcose and chloritic, pyrites, veins of quartz. 40, 62. Quartz and talcose clayey matter, laminæ much curved. 35, 54. Do. in alternate layers. 54. A light yellowish green or olive coloured slate, occurring as a thin layer in the quartz-slate, is nearly pure talc. 114, 40. Chloritic slate, with shining mica, quartzose. 100. With numerous seams of quartz. 64. With shining mica, and thin seams of quartz. 44. Do., much iron-shot. 76. Associated with limestone; cleavages coated with the per-oxide of iron. 88. Rather coarse and soft clay-slate, greenish, with pyrites. 89. Do., talcose. 94. Do., pyrites abundant. 66. Do., talcose. 26. Do., micaceous. The limestones of this Sheet are rather schistose and siliceous. 78. Limestone micaceous, clayey, and schistose. 77. Do., rather purer. 76. Quartzose. 75. Do., with veins of carbonate of lime, and passes into very slaty and earthy. In this Sheet there are greenstone-like rocks at Nos. 37 and 80, which are not truly crystalline rocks, but indurated varieties of the hard greenish quartz rock which occurs elsewhere in the Sheet: thus 101, is a chloritic quartz-slate, with seams of calcareous matter; is slightly gneissose: 30, is a green granular quartz rock, talcose: 37, is a rock precisely similar, having small crystalline portions of felspar imbedded: 79, is a similar rock, with traces of lime: 80, is only a similar rock, with crystalline portions of felspar and small plates of carbonate of lime, in other parts more quartzose, and is similar to No. 40, in Sheet 9.

Sheet 16.—*The rocks of this Sheet, as a whole, are deficient in mica, they have a greenish colour, and a soft and sandy aspect. The gneissose varieties, when they occur, are remarkably deficient in mica, being almost essentially quartz, with imbedded particles and lumps of felspar.*

103. No trace of schistose structure, rock very conglomeritic in structure. 31. Very similar, but slightly schistose. 112. Has the peculiar light green colour. 116. Do., very quartzose. 48. Conglomeritic, with lumps of felspar, greenish in colour. 23. Similar, but coarser. 49. Green, chloritic, with grains of felspar. 113. Do., thin bedded. 34, 102. Do., but coarser. 31, 91. Fine grained, quartzose, gritty. 74. Very quartzose, partings deeply coloured by iron. 82. Greenish, reddish felspar abundant. 33. With felspar lumps. 46. With numerous small particles of white felspar, and small lumps of quartz. 41. Do., even more quartzose. 117. Do., coarser. 110. Do., more micaceous. 39. Do., with some lime and felspar in more angular small masses. 7. Quartz of a greenish hue, with imbedded lumps of quartz and felspar, and thin partings of mica, the rock has a gritty appearance. 9. Greenish quartz rock, with strings of white quartz, and very minute partings of mica of the same colour, so intermixed with the quartz as to be scarcely distinguishable. 34. Very quartzose, gritty, greenish, partings being chloritic. 18. Do., greenish, harder. 135. Do., with small angular grains of felspar. 6. Do., like No. 9. 13. Do., laminæ curved, layers of white granular quartz. 14. Do., more micaceous. 26. Do., curving of laminæ well marked. 24. Do.,

very quartzose. 23, 80. Do., much curved. 104. Do., more micaceous and sandy. 22, 36. Do., decomposed. 131. Do., partings soft and talcose. 59. Do., sandy. 54, 138. Do., laminæ much curved in the small. 63. Do., schistose. 25. Do., with alternate layers of whitish granular quartz. 118. Green, chloritic, with layers of white granular quartz, laminæ curved. 83. Do., with segregated masses of felspar and quartz. 136. Greenish, very quartzose. 62. Do., with thin veins of quartz, and thin partings of clayey matter. 69. Green and sandy. 70. Do., more quartzose, with small scales of dark mica and crystals of iron pyrites. 71. Do., mica more abundant. 38. Do., fracture conchoidal, no trace of schistose structure, chloritic rock. 132. Greenish and chloritic, with numerous thin seams of lime. 61. Similar, wanting the lime. 128. With green talcose partings, and segregations of carbonate of lime. 64, 121. Greenish-grey, partings thin, but regular. 114. Do., with small lumps of felspar. 37. Coarse partings of white mica. 108. Almost all quartz. 85, 93. Quartz, granular and white, in lumpy layers. 3. Do., partings earthy, and deeply coloured by iron. 99. Very granular, gritty, mica evanescent. 12. Greenish, conglomeritic, with veins of quartz. 40. Very quartzose, in irregular and curved layers, partings talcose, whitish-green. 12. Almost solely quartz, could with difficulty be distinguished from some indurated sandstones, traces of lime. 19. Do., with large masses of quartz. 8. Green, with veins and masses of quartz. 50, 55. Chloritic, veins of felspar and quartz. 115. Mica only occurs as thin evanescent partings, not visible on the cross fracture, but giving the rock a laminated fracture; is coarse, greenish, and aggregated. 17. Gritty, iron-shot. 13. Greyish partings of white glittering mica. 106. Greyish, layers irregular. 105. With imbedded lumps of quartz and specks of black colour, (? oxide of iron.) 38. Very quartzose; iron-shot, with occasional grains of felspar. 123. Much discoloured by iron, with minute black spots. 58. Partings coloured deep red. 26. Much curved. 28. Numerous spots of oxide of iron. 35. Parting clayey, deep red. 15. Very quartzose, has much the aspect of some of the harder siliceous sandstones. 21. Greenish colour. 89. Coarse sandy quartz-slate with limestone. 65. Greenish, schistose, with crystals of iron pyrites. 120. Very quartzose and micaceous. 130. Similar. 119, 126. Do., with traces of lime. 127. Do., with masses and strings of quartz. 129. Similar, more micaceous, iron pyrites. 62. Ordinary black crystalline mica, with quartz and carbonate of lime, giving it a crystalline aspect. 66. Very quartzose, with carbonate of lime, coloured by iron, on the cleavages. 2. Coarse, irregular, green, and chloritic. 3. Green, chloritic, laminæ much curved. 18. Do., quartzose. 21. Dark and earthy, talcose, laminæ much curved. 39, 43. Dark earthy, with spots of mica and masses of quartz. 23. Partings of leafy micaceous clay. 33. Dark coloured, closely aggregated clayey slate, with numerous small plates of mica imbedded. 34, 52. Leafy, light green, talcose. 26. Clayey, with veins of quartz, chloritic. 94, 4. Dark earthy clay-slate, with minute scales of mica, coloured by iron. 21. Soft, leafy, light green, talcose, specks of oxide of iron. 2. Talc-slate, thin, smooth, and even, light coloured. 45. Do., coarser, with quartz. 19. More leafy, darker in colour. 20. Talcose, slightly curved. 97, 32, 111. Leafy, greenish talc-slate, discoloured by iron. 92, 73, 47, 84. Of the dark blue, earthy, and foliated variety, which usually accompanies the limestone ; No. 47 is much curved. Limestone is found at several localities in this Sheet ; in general it is of rather a lighter colour than usual, and siliceous. 124. Very quartzose, quartz both granular and in imbedded lumps, beds of light whitish-grey colour, micaceous, with iron pyrites. 88, 10, 8. hard, crystalline, with thick veins of carbonate of lime, accompanied by quartz and chlorite ; pyrites abundant in crystals and crystalline veins. 44. light grey, slaty. 50. Do., siliceous. Veins of quartz, massive and crystalline, with imbedded chlorite, carbonate of lime, felspar, accompanied by iron pyrites and galena, occur at 128 and 127, and a granitic vein of reddish felspar, chlorite and quartz in small quantity at 50, associated with a green chloritic quartz-slate, with carbonate of lime on the fractures, and iron pyrites in small grains. The greenstone-like rocks of this Sheet are but few, and not well marked. 67. A hard, dense, closely aggregated greenstone, (basaltiform) thinly coated on the cleavages with carbonate of lime in crystals. 20, Townland of Ardinarive, is a hornblendic rock, composed of felspar and hornblende ; the felspar in stringy masses, semi-crystalline, arranged parallel to the fibres of the hornblende, giving the rock somewhat of a schistose structure. 53. Appears a compound of grey quartz, massive and compact, and numerous imbedded crystalline portions of light green hornblende, indiscriminately distributed through the rock, and in some cases accompanied by small patches of dark mica in scales. 37. Is similar, with iron pyrites in grains. 36. Nearly similar. 51. Do., but having also many small lumps of greenish compact felspar imbedded, thus giving the rock a gneissose character ; thin coatings of crystalline carbonate of lime on the fractures.

Sheet 17.—*The specimens from this Sheet have a general red colour, from decomposition of iron.*

2. Slightly gneissose. 18. Nearly all quartz. 15. Small portions of felspar —coarse. 16. Do., finer grained. 8. Sandy quartz-slate, red. 12, 93. Chloritic, clayey, with strings of carbonate of lime and quartz, lamination very irregular.

Sheet 23.—*The majority of the specimens from this Sheet have the same greenish colour noticed before, apparently from admixture of chlorite, which also renders the rocks softer. This colour is not observable, however, in most of the gneissose specimens.*

25. Very quartzose, quartz chiefly granular, also with some lumps of massive quartz, mica with chlorite not abundant, rock coarse. 53. Similar, lumps of quartz more numerous. 9, 13. Fine grained, and almost solely quartz. 11. Chloritic, soft and fine grained. 7. Do., crystalline. 4. Greenish and chloritic. 32. Almost solely quartz, chloritic, much undulated. 33. Do., both granular and in lumps. 34. More felspathic, micaceous, and slaty. 44. Coarser, quartzose, iron pyrites. 41, 54. Very quartzose, with small lumps of crystalline felspar, and lumps of massive quartz. 26. Very quartzose, quartz granular. 72. Granular, with imbedded lumps of quartz. 59. Composed of lumps of quartz, in an intimate mixture of quartz and mica. 56. Finer, the lumps smaller. 55. Do., more laminar. 60. 63. Mica only observable in favorable fracture. 70. Do., with a greenish hue. 71. Do., more micaceous. 61. Do., laminæ much curved. 58. Granular quartz and mica, with traces of felspar. 40. Do., decomposed. 62. Nearly quartz rock,

mica only visible on longitudinal fracture. 68. Do., less compact. 33. Small coatings of earthy matter part the quartz. 36. Laminæ much undulated. 97. Partings of earthy mica. 34. Quartz in thick layers, mica in thin partings. 27, 5, 6, 3. All greenish and chloritic, laminæ much curved, iron pyrites in small grains. 15, 35, 39. Rather more quartzose, and not undulated, otherwise similar. 16. Very similar, but more quartzose. 23, 25. Do., more clayey, veins of carbonate of lime. 35. Do., carbonate of lime mixed. 21. Greenish, chloritic, somewhat clayey, and with spots of oxide of iron. 18. More quartzose, and therefore harder. 17, 19, 29. Do., much curved. 46, 37, Do., with carbonate of lime, slightly gneissose. 42, 66, 144. Very quartzose. 64. Curved, slightly chloritic. 38. Quartzose do., with thin layers of carbonate of lime. 52, 67. Partings of shining mica. 1. Do., with small lumps of quartz. 8. Granular and greyish. 22. Very irregular in lamination, slightly chloritic, strings of quartz, much curved. 20. Dark coloured, and micaceous. 21. Quartz-slate mixed with clay-slate, dark and earthy. 19. Thin laminæ of quartz, and micaceous clayey matter. 7. Of ordinary character, numerous crystals of iron pyrites, talcose. 14. Chloritic, with occasional scales of mica, and calcareous coatings on the cleavages. 69. Dark blue, and earthy. 57. Do., with mica. 51. Quartz-slate, with layers of dark clay-slate. 48. Much curved, chloritic. 47. Shining partings of talcose mica, and strings of quartz. 43. Soft do. 27. Soft, slightly talcose. 30. Do., irregular layers of quartz. Limestone occurs at 73, schistose, micaceous, pyritic. 65, earthy and micaceous. No trap-like rocks occur in this Sheet.

Sheet 24.—*The rocks in this Sheet are principally quartzose though slaty; being nearly quartz rock, as the mica generally occurs only in thin partings or coatings on the laminæ; a considerable number, however, of clayey slates also occur.*

41. Quartz very abundant, both in small lumps and granular; felspar in crystalline grains. 43. Do. 42. Slightly more micaceous. 105. Very quartzose, imbedded crystalline portions of felspar. 96. Do., granular. 38. Do., slaty. from prevalence of mica. 40. Very much discoloured by iron; sandy. 11. Nearly quartz rock; small grains of felspar imbedded. 47. Decomposed. 78. Scarcely a trace of mica. 31. Do., granular. 45. Do. 57. Compact and granular. 48. Scarcely a trace of mica. 52. Do., granular. 99. Very quartzose. 12, 35, 37, 54, 55. The mica is evanescent; not visible except on a favorable laminar fracture. 30. Do., small lumps of massive quartz imbedded. 32, 46. With greenish tinge from admixture of chlorite. 17. With small lumps of quartz. 16. Laminæ much curved. 107. Slightly gneissose, yellowish from ochre. 92, 58, (or Sheet 16, No. 2), talcose. 51, 53. Clayey, with irregular masses and strings of quartz, slight traces of common garnet. 104, 13. Similar, no garnets, much iron. 56. Laminæ greatly curved, slightly chloritic. 15. Dark earthy slate, blue. 44. Do., slightly curved. 33. Light coloured, talcose. 34. Do., laminæ slightly curved. 49. Dark coloured, slightly talcose. 100 B. Talcose, much coloured by iron. Limestone occurs in two places. The only rock which has anything of the trap character in this Sheet occurs at No. 36. It

is a compound of fibrous hornblende, and compact felspar, with quartz, and traces of chlorite; the quartz is in irregular strings. The structure of the rock is decidedly schistose, the ingredients being arranged parallel to the fibres of the hornblende; colour is green, of rather a dark tint.

Sheet 26.—Of this Sheet the schists occupy a very limited portion. On the whole, they have a granitoid character; that is, they are less schistose than usual. The mica, (generally black,) is not abundant, and occurs rather in scales disseminated in the quartz, than as forming regular partings. When it becomes more plentiful, the rock is laminated, and of a clay-slate aspect, the mica forming thin continuous layers. This variety seems in most cases to be associated with the limestone. When the mica vanishes, the rock becomes quartz rock, rather granular than massive. The rocks generally are hard and thick bedded, having in the large a slaty fracture, but in the small an uneven or even imperfectly conchoidal one.

49. Imbedded semi-crystalline portions of felspar of reddish colour. 50. Slightly gneissose. 51, 52, 53. Slightly calcareous. 54. Do., felspar reddish. 60. Slightly calcareous; small lumps of bluish quartz. 64, 67. Mica more abundant, though not in continuous layers. 46. Hard, and not schistose. 48, 93. Very quartzose. 79. Mica in very thin and almost evanescent partings. 78. Much discoloured by iron. 89. Mica in shining partings. 88. With semi-crystalline particles of lime. 61. Veins of carbonate of lime, and of highly crystalline, quartz, felspar, and mica. 71. Quartzose slate. Limestone is found in this Sheet, at 56, micaceous and iron-shot; veins of pure carbonate. 63. Accompanied by dark slate; pyritic. 66. Light coloured and highly crystalline. 96. Crystalline. 87. Do., with pyrites. The trap rocks of this Sheet are few. At 68, 59, 91, they are largely crystalline greenstones, of hornblende and felspar, with traces of chlorite, having no approach to laminar arrangement; while at 92, is a rock essentially composed of the same ingredients, though not having the same crystalline arrangement. The rock is here rudely schistose, from the parallel arrangement of the ingredients.

Sheet 28.—Principally clay-slate variety.

7. Very quartzose; mica only visible on the cross fracture. 15, 12. Dark, earthy, and micaceous, with specks of iron. 88. Talc-slate; light yellowish-green. 11. Do., partly decomposed. 14. Slightly talcose. 13. Much contorted, talcose. Limestone occurs at 86, very earthy and impure. 3, 2. Light coloured and siliceous. Galena not uncommon.

Sheet 29.—The rocks quartzose, and have a prevailing gneissose tendency.

73, 7, 19. Very coarse; large lumps of felspar and quartz. 124. Very quartzose; coarse. 55, 53, 98, 69, 139. Do., approaching a granitoid form.

141. Do., felspar crystalline; mica not abundant. 48. Do., fine-grained. 81. Granitiform; mica more abundant; laminæ can be traced. 67. Felspar crystalline, quartz, granular, mica dark green. 99. Do.; lumps of quartz imbedded. 143. Quartzose, granitic in structure. 50. Do. do., decomposed. 78. Do. do., with strings of quartz. 77. Very granitic in structure; fine grained. 25, 156, 52. Very felspathic; felspar white; rock very like some of the light-coloured felspathic sandstones. 51. With imbedded lumps of quartz. 161. Granitoid, dark black mica in good sized plates. 160. Similar, but mica much less plenty. 23. Slaty; light-coloured mica forming thin partings, with small patches of dark-coloured ditto. 138, 76. Distinctly bedded, otherwise granitiform. 72, 62. Fine-grained do., mica black. 80. Small bits of blue quartz imbedded. 16. With patches of earthy blackish mica. 21. Do., decomposed. 47. Mica very trifling in amount. 137. With lumps of quartz; coarse. 163. Felspar crystalline. 94, 17. Very quartzose, with grains of felspar. 130. Granitiform; more micaceous. 140. Very granitic in character, the mica green, and hornblende-like. 53, 61, 13. Very quartzose, with lumps of quartz imbedded. 152, 45, 120, 165. Do., rather sandy. 153, 90. Laminated quartz rock, mica only visible on longitudinal fracture. 91, 95, 97, 154. Do., partings slightly talcose. 5. Do., with grains of oxide of iron. 167. Laminated quartz rock. 164, 114, 110, 113. Slightly micaceous. 106. Quartz grey and coarser, in lumps. 105, 111. Sandy from decomposition. 89. Greyish-green; mica evanescent. 92, 42. Do., laminæ curved. 101. Quartz rock, with small specks of granular iron pyrites through the rock, and galena on the cleavages. 20. Quartz and mica irregularly mixed, the former predominates. 32, 56. Varies to slightly gneissose. 18. Mica soft and talcose; lamination very rude. 135, 60, 12. Decomposed. 123, 115. Slightly gneissose: laminæ curved. 57. Quartzose. 15, 10. With more slaty variety. 11. Quartzose. 39, 127. Very quartzose. 40. Do., mica rather clayey. 116. With small lumps of quartz; rather clayey. 102. With strings of quartz; mica talcose. 41. Mica dark and clayey. 129. Dark crystalline mica, with crystalline portions of carbonate of lime and strings of quartz. 96. Precisely similar, with crystals of pyrites. 145. Coarse, with carbonate of lime. 8. Slaty variety, the clayey matter in distinct layers. 6, 84. More clayey. 30. Mica soft and talcose, with minute acicular crystals of schorl. 63. Very micaceous. 119. Do., with angular fragments of quartz. 26, 28. With numerous small specks of ochre and minute fragments of quartz; small acicular crystals of schorl. 37. With angular fragments of quartz. 134. Quartz and mica nearly equal in amount. 74. Mica, very clayey. 138. Passes into clay-slate; schorl in small crystals. 125. Very similar, with grains of quartz. 93. Laminæ curved, quartzose. 145. Dark and micaceous. 10. Soft and talcose. 107. Talc-slate. 44. Much discoloured by iron. 104. Dark-coloured and earthy, with seams of carbonate of lime; nodules or irregular veins of quartz, crystalline felspar, and chlorite, occur in this. Limestone, of the ordinary characters are frequent in this Sheet. 108. Light-coloured and siliceous. 150. Micaceous and flaky. 151. Do., with veins of pure crystalline carbonate of lime. 148. Flaky. 128. Micaceous and quartzose. 126. Do., very siliceous. 132. Highly crystalline. 39. Micaceous. 58, 85. Crystalline, but earthy. The trap-like rocks of this Sheet have a more decidedly crystalline structure than those of any other district of the schists. Here, however,

the two varieties are still clearly defined. 27. A largely crystalline greenstone of hornblende and felspar, the latter yellowish-white, forming a rich contrast to the dark green hornblende. 49. Identical, except that it is smaller grained. 52. Still smaller grained, felspar white; numerous spots of red oxide of iron. 29. Fine grained; felspar less abundant. 75. Very similar to No. 49, but less felspar. 122. Felspar corresponds in colour with the hornblende; distinctly crystalline. 133. Very fine-grained felspar, greenish and compact. 118. Similar; quartz occurs in both these in minute quantities. 79. Do.; more hornblendic and fibrous; hornblende forms much the largest proportion of the three last. The same ingredients precisely, but not having a truly crystalline arrangement, are found in the next class. 71. Felspar not abundant, approaches to the schistose or parallel arrangement. 22, 64. Felspar more plentiful and rock more schistose. 82. Almost solely hornblende. 36. Felspar white, in long crystalline strings, nearly equal in amount to the hornblende. 68. A finely crystalline and small-grained rock of hornblende and felspar, ingredients scarcely distinguishable; the rock on close examination may be seen to have somewhat of a schistose arrangement of the ingredients. 158. Very similar; quartz in small quantity. 121. Do.; but quartz replaces the felspar; is hard and dense. 136. Nearly similar to 71. 117, 65. A fine-grained crystalline compound of hornblende and quartz of dark colour; both are quartzose and have a somewhat tabular fracture. The rock which when decomposed affords the ochreous soft rock at No. 155, appears to be similar to No. 27: that at No. 157, similar to the more schistose variety. The junction of greenstone and quartz-slate at Nos. 49 and 50, appears to be accompanied by veins of the one rock intruding into the other.

Sheet 30.—*The rocks are quartzose; generally light-coloured, hard, and not very schistose; a few clayey beds, but not sufficiently numerous to affect the general character; a bluish colour not uncommon, appearing principally in those rocks which are slightly calcareous.*

133, 126. Coarse, with but little mica. 14, 184. In cross fracture granitoid. 147, 148. Do., with masses of quartz. 146. Slightly more crystalline. 144. Coarse, with lumps of bluish quartz. 155. Decomposed; quartz, granular and sandy. 135. Very quartzose with chlorite, giving it a very granitiform look. 41, 64. Quartz, granular, in lumps: felspar in small patches. 87. Quartz in irregular layers: felspar in small crystalline portions. 152. Mica, soft and talcose. 84. Coarse, with numerous spots of oxide of iron and chlorite. 97. Felspar in crystalline lumps: mica black. 98. Do., less micaceous. 143. In the cross fracture has a granitoid structure; felspar red and abundant. 82. Very quartzose; quartz in irregular layers; much discoloured by iron. 140. Much decomposed. 141. More siliceous. 6, 71. Somewhat granular. 195. Slightly gneissose quartz-slate. 196. Very hard and quartzose, granitoid. 197. Do., with small spots of felspar. 199, 188. Coarse and slightly gneissose. 134. quartz-slate do. 206 B. With traces of chlorite; rock dark coloured, felspar crystalline. 96. Very quartzose, with lumps of felspar and quartz. 153. Granitoid from arrangement of mica not in continuous sheets, but scattered through the quartz. 137, 202, 189. Very quartzose; felspar, but not abundant. 94. Mica, black and crystalline; felspar in crystalline small fragments; quartz in strings and lumps. 88. Mica; very green and chloritic. 85. Very quartzose, with imbedded lumps of quartz. 103. Irregular seams of quartz. 124. Greyish quartz, with small lumps of quartz and spots of oxide of iron. 130, 54, 10. Quartzose; not laminated. 134. Do., slightly gneissose. 182. Decomposed and sandy. 30, 201. Dark coloured quartz with black clayey mica, contorted. 191. Granular and sandy. 186. Coarse and quartzose. 200. Decomposed. 104, 19. Very quartzose. 217. Micaceous; red partings. 136. Mica light coloured and clayey; chlorite and masses of quartz. 58. Very quartzose. 65. Soft and sandy. 215 B, 218. Micaceous quartz-slate. 187. Do., soft and earthy. 89. Quartz, lumpy and contorted; chloritic. 212 B, 95. Very quartzose, with small lumps of quartz. 18. Mica, dark and clayey. 20, 21, 22. Mica in very thin, almost evanescent partings; only visible on the cross fracture. 22 B. With specks of ochreous oxide of iron. 23. Do., a little more micaceous. 27. Undulated. 28. Oxide of iron in specks. 25 B. Greyish colour. 36, 221. Coloured by iron. 222. Partings deep red. 212. Quartz greenish from admixture; traces of pyrites. 118. Specks of oxide of iron. 176. Quartzose, with lumps of quartz and felspar, and disseminated carbonate of lime. 208 C, 207, 210, 168, 86. Do., more slaty. 206 B. Very quartzose, with numerous scales of black mica imbedded. 171, 198. Schistose from mica. 37. Coarse. 132. Calcareous and quartzose, granitoid. 117. Coarser; mica in more regular partings. 75. Rather clayey. 26. Mica light, soft, talcose, abundant. laminæ much curved. 178. Greenish and chloritic. 59. Do., much curved. 126. Dark, earthy, clayey, iron-shot. 181. With traces of lime. 163, 159. Dark coloured, with black clayey partings. 205. Mica, soft and talcose, abundant. 134. With small crystalline grains of felspar; mica, soft and talcose. 165. Do., dark-coloured and clayey, laminæ curved. 200. Similar, but not undulated. 177. Dark coloured and clayey, with carbonate of lime. 185. Schistose; partings being of soft talcose mica with small crystals of schorl: felspar crystalline; mica in crystalline scales. 214. Very similar; more talcose. 216. Somewhat similar; quartz more abundant, in irregular strings or layers; laminæ much curved: much iron shot. 158. Somewhat similar; not talcose. At 129 C, veins of carbonate of lime, quartz, chlorite, and felspar, occur. The limestone is abundant throughout the schists of this Sheet: in general character it is micaceous; pyrites not uncommon. 190. Micaceous and pyritic. 181. Flaky and ditto. 169, 113. Micaceous. 80, 77. Do., and earthy. 66. Do., and pyrites. 24. Do., impure. 1. Do., and siliceous. 52. Do., and pyritic. 120. Do., and siliceous, with thin veins. 122, Earthy and flaky. 157, 115, 56, 48. Rich, and tolerably pure. 17. Do., rather earthy. 160. With pyrites. 127. With crystalline veins of pure carbonate of lime. 102 (B), 7, richly and largely crystalline. 68. Associated with quartz rock. This Sheet affords a considerable number of hornblendic and other rocks, which have a general greenstone character. Of these, on examination, many have proved to be merely varieties of quartz rock; having a green colour, probably from minute intermixture of chlorite; few are crystalline. 46. Is a very compact quartz rock; greenish (coloured probably by chlorite), granular and glistening. 45. Is similar; appears slightly more crystalline, and has small specks of mica imbedded. 78. Is similar precisely to No. 46; abounds with minute grains of iron pyrites disseminated. 53. Very similar, without the pyrites. 9. Somewhat coarser or larger grained, but otherwise similar. 8. Do., with small scales of mica and traces of felspar. 114. Similar, with patches of bronze-coloured mica. 116. A little deeper in colour, otherwise like No. 46. 112. Similar, with dark chlorite in small quantity. 111. Slightly hornblendic, but quartzose. 203. Very similar to 45, 46, &c. 5. Is a dense chlorite rock, partings of chlorite and fibrous chlorite disseminated, is rudely schistose. 47. Is nearly similar; fibrous; light green and minutely crystalline. 70. Hard, quartzose chlorite rock, fibrous. 2. Hard quartz rock, with minute scales or fibrous partings of chlorite; pyrites occurs disseminated. 12. Very similar. 81. Quartz with chlorite admixed, with small lumps of quartz of greenish colour imbedded, and minute specks of mica. 16. This curious rock seems to be a compound of grey quartz, massive and compact, and numerous, imbedded portions (crystalline) of light green or greyish-green actynolite, or hornblende: these are indiscriminately distributed through the rock, and in some cases are accompanied by small patches of dark mica in scales. 11. A similar rock; crystals smaller but more abundant; quartz of a deeper grey. 15. Differs solely in size of grain, being smaller. 179. Very similar; patches of dark mica more numerous and more equally disseminated, while the crystalline masses of hornblende or actynolite (? felspar,) are less abundant. 180. Similar, quartz is darker in colour, rock more crystalline; difference is probably due to the rock being less decomposed. 51. Nearly identical with 179; quartz is light grey; occurs in lumpy masses, giving the rock a very uneven or nodular fracture. 90. Very similar. 44. Do., darker in colour and finer grained. 206. The rock is of the same general character, but mica of a dark bronze colour forms thin evanescent partings, and the quartz is of the same greenish-grey tinge and granularly compact character. 171. Similar; the thin partings numerous but irregular. 166. Differs principally from the larger grained rocks above, in the smallness of its grain and the more equal intermixture of the ingredients, is decidedly schistose and thin bedded. 79. Very dense and hard; but rendered schistose by thin partings of mica in minute scales. 49. Very similar, with numerous small patches of carbonate of lime; quartz occurs chiefly in lumpy layers. 31. Essentially similar, but fine grained and more nearly homogeneous in aspect. 128. This would by some be called hornblende slate; the rock is schistose; the schistose structure being caused by thin partings of fibrous and silky hornblende (?), the mass of the rock is however quartz, of a dark colour. It cannot be truly called schistose, but from the parallel arrangement of the fibres, has somewhat of that structure. 129 B. More largely crystalline, but essentially of the same ingredients; coated by crystals and crystalline seams of carbonate of lime on the fractures. 209. Is an intimate intermixture of hornblende and quartz, with carbonate of lime arranged parallel to the prismatic planes, and on the cross fracture exhibiting crystalline planes; thin threads of carbonate of lime also traverse the rock. 211. Similar, but more schistose and more calcareous. 138. Very similar. 131. Rather lighter in colour; no lime, but the felspar (crystalline) in greater abundance. 173. Distinctly crystalline, and having a crystalline arrangement; essentially, however, of the same ingredients.

3. Very similar, but has somewhat of the schistose structure; numerous small grains of pyrites imbedded. 200 B. Similar. 219. Essentially composed of hornblende and felspar, the latter of a yellowish-white, in stringy semi-crystalline portions, arranged parallel to the fibres of the hornblende. 154. Very similar. These rocks, though many of them have little of an igneous or erupted character, have been all taken together, in order to show the gradations from one into the other. Not more than three or four appear to have a distinct character; among these may perhaps be cited Nos. 173, 200, 3. Some of the other varieties appear to be continuous for some distance, as in 46, 45, 78, 53, 9, 8, 203.

Sheet 31.—*The schistose rocks of this Sheet, correspond in general character to those of Sheet* 30.

336. Abounding with spots of red oxide of iron. 9. Similar, mica more plenty; dark and hornblendic. 13. Coarse, and very quartzose. 60. Reddish felspar abundant; small lumps of bluish quartz. 70, 50. Very similar: a little more schistose. 54, 55. Do., slightly calcareous. 6. Felspar in reddish patches. 19, 69. Very quartzose and hard, approaching to a granitic form. 17, 4. Granitoid, quartz both granular and in lumps. 3, 446. Slightly gneissose; fine grained, granular. 4. Soft, decomposed, and sandy. 42. Similar in composition, coarser grained and harder. 37. Mica, dark green, crystalline. 339. Very much charged with iron, and decomposed. 16. Granitoid; very hard, with black mica disseminated. 454. Very quartzose, slightly granitoid. 8. Do., slightly calcareous. 33. With small pieces of reddish felspar. 411, 144. Quartz and mica in alternate layers. 441. Very quartzose, with small scales of mica disseminated, and carbonate of lime in veins, with iron pyrites. 348, 414. The mixture of lime gives these rocks a blue colour, and very limestone appearance; they are very quartzose and hard; the mica is black. 7. Micaceous. 332. Very quartzose. 345. Very calcareous. 436. Do., and quartzose, with traces of pyrites. 413. Micaceous. 167. Very quartzose, and deeply coloured by iron. 169. Do., mica almost evanescent. 165. With masses of quartz. 452 B. Dark-coloured quartz, with veins of carbonate of lime, coloured by iron. 408. Mica, green and hornblendic, granitic in structure, like 140, Sheet 29. 171. Slightly granular. 344. Do., with lumps of massive quartz. 330. Lumpy and quartzose. 442. Granular and sandy. 2. With veins of quartz. 164. Mica, soft light green, and talcose. 43. Traces of felspar. 11. With small crystalline pieces of felspar. 53. Mica green, with patches of darker colour. 12. Same as 11; more distinctly crystalline, and with layers of quartz and clayey mica. 34, 35, 214, 447, 41. Micaceous schist. 39. Talcose; specks of oxide of iron. 2. With small crystals of schorl, and angular grains of quartz and felspar; talcose. 10. Talcose and clayey. 337. Dark and earthy. 453. Do., laminæ much contorted. 63. Talcose; with small crystals of schorl. 334. Much contorted and decomposed. 328. Much iron-shot. 412. Very micaceous; mica crystalline. 1. Minute crystals of schorl. 346, 349, 342. Dark and earthy, with limestone. Limestone is very abundant in this Sheet; principally, however, confined to the portion in the immediate neighbourhood of Dungiven. Its prevailing character is crystalline, in some places largely so; and then the limestone is thick-bedded and has no trace of schistose structure. In a few localities the colour is green or bluish-green, probably from

admixture of serpentine. 452. Limestone, composed of layers of highly crystalline limestone and quartz. 449 B. Highly crystalline, and with veins of greenish limestone (from serpentine). 439, 435, 418. Highly crystalline. 166, 164 B. Crystalline and pure. 163. Do., ferruginous. 161 B, 147. Do., with crystalline veins. 431. Siliceous of a green or bluish-green colour. 417, 421, 201. Do., ferruginous. 145, 338, 329. Micaceous. 350. Do., and ferruginous; flaky. 415. Do., and earthy. 215, 205. Earthy and flaky. 425, 420. Earthy and micaceous. 203. Slaty, but rich. 202. Very pure and lighter coloured. 200, 424, 422. Of ordinary character; good. 326. With pyrites. 406. Dark, crystalline, and with pyrites. Galena occurs in several localities, though not in any quantity. Pyrites occurs both disseminated through the limestone, and in crystalline coatings on the cleavages or fissures. The hornblendic rocks of this Sheet are similar in almost every respect to those of Sheet 30. 409. Much decomposed; appears, however, to be a compound of hornblende, and felspar, in irregular laminæ. 445. Hornblende fibrous, dark, felspar white or whitish, in strings parallel to the fibres of hornblende. 443. Very similar, hornblende lighter in colour and more actynolitic. 5. Similar, larger grained and ingredients more separated. 36. A rock very similar, though the ingredients have not quite so much of the schistose arrangement. 40. Hornblende here forms a much larger proportion of the ingredients, and quartz has in great part replaced the felspar. 44. Almost solely hornblende coloured by iron; the rock has not, however, a crystalline arrangement, but a flaky structure. 62. Is very similar to 409. 61. Very similar, finer grained; ingredients more intimately intermixed, fissures coated by peroxide of iron. 190. A dark, fine-grained, and closely aggregated greyish-green, quartzose rock, probably owing its colour to admixture of chlorite. 56. A fine close-grained hornblende rock, consisting of minute intermixture of hornblende and quartz, of dark colour, and having small crystalline pieces of carbonate of lime imbedded; has somewhat of a flaky structure. 453 B. A greenish-grey quartz rock, cemented by a light green talcose matter, not crystalline; is somewhat like the curious rock, described in Sheet 30, Nos. 16, 15, 11, &c. 334. Is a hard chlorite rock, of quartz and greenish chlorite in thin partings; the quartz is in grains and the ingredients are intimately mixed. 46. A hornblende rock (hornblende and quartz), the hornblende fibrous, and the quartz in small masses; carbonate of lime coats the fissures. 432. Very similar, but denser. 433. Is much more quartzose, nearly similar to 190, but has occasional small portions of felspar, which assume somewhat of a stringy arrangement like 44, &c. 434. Is more hornblendic; hornblende distinctly crystalline; quartz minutely admixed and of a darkish green colour. 437. Is of the same ingredients, more distinctly crystalline; felspar crystals occur, forming a hornblendic syenite or syenitic greenstone. 437 B. Is a finely granular quartz rock of nearly similar colour, but with scarcely a trace of hornblende; fracture, on the large, somewhat slaty. 438. Is a similar rock distinctly laminated; thin, scarcely discernible partings of mica? iron pyrites on the cleavages. 410. Is very similar to 437 B. 168. Do., a little more largely crystalline. 170. Distinctly crystalline, greyish-green, compounded of greyish-green felspar (compact), and hornblende of diallage character and similar colour, the hornblende alone crystalline; approaches in character to No. 434. 382. A rock essentially of dark-coloured quartz and black crystalline mica. The mica forms irregular platings or coatings; dark quartz forms the larger portion of the rock. 383. Similar ingredients; the mica in more regular partings; but the cross fracture is more crystalline, owing to the mode in which the quartz occurs; also many small crystalline pieces of slightly reddish felspar. This rock, though more crystalline, is at the same time more schistose than 382. 8. Composed of dark green hornblendic mica, forming irregular and thick partings, in which are imbedded numerous small masses of greyish quartz and crystalline felspar. The crystalline structure is only visible on the cross fracture. 15. Is essentially similar, but has here lost all schistose structure; the felspar is in larger plates, the quartz still uncrystalline.

These latter specimens have been here considered only as they are of the same general form. They cannot be considered trap rocks, and are not even much altered.

Sheet 32.—*The primary rocks of this Sheet are distinctly schistose; felspar is an ordinary ingredient, rendering them gneissose; the clay-slate variety only seen in a few places, and even then not well marked.*

50, 53, 52, 3. Quartz in granular masses; felspar abundant; mica in shining coatings. 2. Quartz-slate, with felspar in irregular layers or nodules. 37. Felspathic and quartzose, granular, giving the rock somewhat of a conglomerate structure. 40, 57. Mica abundant in continuous plates rendering the rock schistose. 11. Iron pyrites disseminated. 38, 34. Fine-grained and schistose. 49. Do., felspathic. 1. Associated with talcose clay-slate, and with crystals of schorl. 39. Felspathic and granular. 35. Do., decomposed. 139. Semi-crystalline and granitic. 25. Schistose. 4. Very quartzose; iron pyrites in minute grains. 5, 48. Even more siliceous. 22, 24. Distinctly schistose, and slightly gneissose; very ferruginous. 10. Ferruginous. 6, 56. Quartz-slate of ordinary characters, coloured by iron. 29. Very micaceous. 26. Do., mica black. 30. With chlorite. 12. Talcose clay-slate, traces of iron pyrites. 1. Slightly talcose, with minute prismatic crystals of schorl. 36. Very soft, ditto. 13. Composed of talcose mica, with numerous slender crystals of schorl, and having imbedded many crystalline angular lumps of felspar, of a reddish colour.

A vein of crystalline quartz, mica, felspar, and chlorite, with iron pyrites, occurs at 2. Between 48 and 49, is a vein of massive brown quartz, with schorl in aggregated crystals (prismatic and curved), and a little felspar. Between 15 and 16, a vein of chlorite and carbonate of lime, with felspar. At 13, is a granite vein; mica in well marked crystallized tables of brown colour. Limestone occurs at 72, crystalline, and with numerous seams of pure carbonate of lime; at 70, slaty and micaceous. *Hornblendic Rocks*—71. On close examination, the slaty structure of this rock can be observed; but it is crystalline hornblende, is light coloured and actynolitic; the rock, if more slaty, would be called actynolite-slate. 73. Is similar, but more felspathic and quartzose. 51. Greenstone-slate, composed essentially of hornblende and felspar in alternate irregular layers, the hornblende predominating.

Sheet 34.—*The schists of this Sheet approximate in general to gneiss; they are quartzose, the quartz not having the usual laminar arrangement, but occurring in separate lumps, arranged either promiscuously or in layers. This arrangement gives a gneissose aspect to the rocks, even though felspar be absent.*

22, 25, 23. Gneissose: felspar crystalline; quartz massive or in strings; mica in irregular and curved layers, consisting of small plates or fragments; schorl in prismatic and acicular crystals, often curved, is abundant. 42. Do., with garnets. 43, 46, 48. Similar, but no schorl. 45, 47. Do., with only slight traces of schorl. 61. Quartz, granular and white. 8, 41, 51. Passing into a more slaty variety. 5. Gneissose, hornblendic aspect, but without hornblende. 15. Almost solely felspar and quartz: quartz both in lumps and granular. 14. A little more micaceous, lumps of bluish quartz. 26. Almost solely felspar and quartz; lumps of bluish quartz. 29, 12. More slaty, but similar in other respects. 34. Mica forms thin shining partings, only visible on the longitudinal fracture. 18. Very quartzose. 20, 53, 60. Similar, slightly more micaceous, the last decomposed. 44. Very quartzose. 49. Mica dark, and earthy in flakes. 21. Quartzose and slaty; mica of dark colour, in thin partings of highly metallic lustre. 54. Fine-grained. 28. Granular from decomposition. 71, 70, 9, 35, 13. Mica abundant, rendering the rock flaky. 6, 2. Do. do., quartz granular, and also in lumps. 4. Mica green and chloritic. 73. Very quartzose and laminated; mica evanescent. 39, 19. Mica green, abundant; quartz in iregular masses and strings: felspar in crystalline grains. 38. Do., more siliceous. 68, 24. Mica more abundant. 1, 38. Quartz-slate, quartz granular, mica not plenty, in thin partings. 33. Very quartzose; quartz in lumps. 31. Very compact; not regularly laminated; slightly gneissose. 50. Quartz in nodules and irregular layers; rock coarse. 65, 55. Quartz not abundant; rock clayey. 11. Soft and chloritic; small crystals of schorl. 10. Clay-slate associated with gneissose variety. 56. Mica dark and earthy; quartz in separate nodules or lumps. 52. Do., more quartzose. 32. Earthy; schorl abundant in acicular crystals; both curved and straight, arranged both on and across the laminæ. 62, 63. Have calcareous matter disseminated. Limestone occurs at 64 and 63; micaceous. Hornblendic rocks are here somewhat more distinctly crystalline, and present less traces of bedding than is usual in this district. 54. Ingredients distinct, paste is of semi-crystalline and crystalline hornblende, in which are many granular small masses of felspar of a brownish-white colour: in the felspar are minute angular grains of iron pyrites. 37. Similar; acicular crystals of schorl, 14 (b.), 28 (b.) very fine-grained crystalline rock, dark green, ingredients scarcely distinguishable, but apparently of hornblende and quartz or felspar. 17. Is a rock very similar to the eye, but under the glass it appears to be solely quartz. Common garnet occurs in small quantity at 42 in this Sheet.

Sheet 35.—*Viewed as a whole, the rocks of this Sheet have a darker colour than is general; many of them are of a deep red or ferruginous colour, and look sandy; they are very quartzose, and have a prevailing gneissose tendency.*

15. Mica black, not plenty; quartz abundant, felspar in granular lumps.

24, 13, 16. Very similar; mica more abundant. 89. Mica dark greenish, felspar abundant in semi-crystalline lumps, quartz both in layers and imbedded lumps of bluish colour; coarse. 171. Felspar red and distinctly crystalline; mica soft and talcose, both dark and light green; traces of schorl. 62, 2, 66, 173. Felspar red and abundant, lumps of bluish quartz. 74. Do., with more mica. 47, 174. Very coarse and quartzose; mica not plenty. 223. Decomposed, but appears crystalline. 231. Soft and earthy; mica forms partings; felspar in separate lumps or masses. 20, 21. Mica abundant, and very soft; traces of felspar, partly decomposed. 23. Similar; mica is greener in colour, and the rock altogether of a more crystalline character. 17. Passes to granitic, does not exhibit any trace of the schistose structure on the cross fracture, though this is evident on the longitudinal ditto, fine grained. 19. Similar, but more quartzose. 72. Of the ordinary quartzose character. 71. Similar; mica black, more abundant. 64. Do., coarser. 233. Very quartzose. 228. Coarser grained, and slaty. 45, 4, 5, 10, 11. Quartzose. 18. Nearly similar; mica softer and looking more earthy; long acicular crystals of schorl, near the layers containing which the rock is more crystalline. 3. Quartz in masses, as well as intermixed. 184. Quartz lumps; felspar in small crystalline masses. 176. Soft, fine-grained, granular. 77. Do., mica green. 69, 172. Do., mica black. 189. Sandy, quartz in lumpy layers. 163. With thin layers of clay-slate, in which are found slender crystals of schorl. 75. Mica light coloured, with occasional scales of black do. 219. Coarse, ferruginous, like 62, 66, &c. 140. Mica green and abundant. 1. Composed of alternate layers of black shining mica and quartz, with traces of felspar; the layers very much convoluted. 8. Mica soft, green, and talcose; felspar reddish and crystalline; quartz not abundant, in strings or semi-crystalline lumps. Schorl abounds in crystals on the laminæ. 81. Very quartzose; quartz in lumpy layers; small bits of bluish quartz. 229. Mica almost evanescent; lumps of bluish quartz. 82. Nearly quartz. 78, 85. Very quartzose, with traces of felspar. 76, 46. Do. do., fine-grained and reddish. 187, 35. Mica black, not abundant. 25, 179. Very quartzose, dark coloured. 200. Ferruginous. 199. Lamination irregular. 170, 178. More micaceous, and nearer to the ordinary quartz-slate. 50. Mica black. 182. Granular and soft. 209. Very much iron-shot. 181. Very hard and granitiform, mica not occurring in regular flakes or partings. 180. Fine grained and semi-crystalline. 7. Quartz in lumpy layers. 48. Mica dark and metallic. 68. Ingredients intimately intermixed. 183. With layers of quartz. 49. Mica of light-grey colour, with occasional small scales of black ditto. 232. Lamination irregular, and curved. 225. Mica talcose; quartz in thick layers. 192. With traces of felspar; slightly granitiform, from arrangement of the ingredients. 216. Ferruginous, sandy. 82. Very red do., do. 87. With layers of crystals of schorl in talcose mica. 167. Mica very talcose. 165. Less micaceous; quartz more in lumps. 169. Talcose quartz-slate, with small crystals of schorl. 168. Very similar, and having also numerous scales of black mica in the light-coloured mica or talc. 84. Quartz and clay schists, with thin partings of white silvery mica; the clay schist dark coloured, with small crystalline lumps of quartz and iron pyrites. 79, 180. Similar clay-slate. 224. Do., do. with schorl, talcose. 82, 223.

Seams of similar clay-slate occur here, much coloured by iron. 185. Talcose. 211, 217. With small crystalline lumps of felspar. 201. Coarse. 227, 46, like No. 224, the last decomposed. 220. With small crystals of felspar and quartz. 188. Green talcose slate, with crystals of schorl. 49. Micaceous, with small crystals of schorl. 230, 212. Quartzose clay-slate. 73, 177. Passes into quartz-slate with talc. 186, 80. With pyrites. 221. With carbonate of lime, disseminated in small crystalline portions. 175, 240. Are rocks, the prevalent constituent of which is dark green hornblendic looking mica, with crystalline portions of felspar and quartz, and carbonate of lime; the whole has much the aspect of hornblende-slate. 9. Similar; mica and quartz minutely intermixed. 12. Do.; quartz more abundant, and in larger grains; carbonate of lime disseminated. 90, 65. The mica is dark green, and very chloritic in character, giving the rock the aspect of chlorite-slate. Schorl in crystals of some size and beauty, associated with red felspar, quartz, and chlorite, with iron pyrites, is abundant in veins at 76 and 70. Chlorite, with large crystalline masses of felspar, and small portions of brown spar, occurs at 226.

Sheet 36.—*The primary rocks of this Sheet are in general character very similar to those of Sheet* 34. *Iron appears more prevalent, giving the rocks, on exposure, a rusty colour.*

81. Coarse and quartzose. 57. Coarse, slightly clayey; quartz not so abundant. 44, 45. Felspar abundant, reddish; mica forms thin partings. 40. Mica abundant; quartz in lumps rather than layers. 39. Mica less plenty; more of ordinary quartz-slate character. 50. Mica in thin partings and disseminated; felspar crystalline, and quartz occasionally so. 193. Coarse, quartzose. 29. Slightly gneissose. 46, 48, 54. Quartz abundant, and in veins. 36, 37. Mica scarcely seen. 30. Slaty varieties; iron pyrites forms a thin coating on the fissures of the quartz which occurs in irregular masses imbedded in the slate. Small crystalline portions of common garnet also occur imbedded. 28. With grains of quartz, and small crystals of schorl. A vein of carbonate of lime, sulphate of barytes, and felspar, with carbonate of iron, occurs at 39. At 46 schorl is plentiful in slender crystals on the laminæ. A granitiform vein of chlorite, felspar, and mica, with traces of iron pyrites, at 31.

Sheet 39.—*The mica of the rocks of this Sheet is of a remarkably brilliant metallic lustre; it occurs generally in continuous plates, or partings, which give the rocks a very peculiar character when viewed on the longitudinal fracture.*—(*See other Sheets*, 40, 44, *&c.*)

1. Mica is green, clayey; brilliantly metallic. 2. Dark coloured mica, with patches of light green talcose do.; carbonate of lime is disseminated; quartz in irregular granular lumps. 3. Very quartzose. 4. More micaceous; same brilliant metallic lustre. 5. Similar to No. 1; quartz in both occurs in small granular masses.

Sheet 40.—*The primary rocks of this district, independently of distinctly metamorphic rocks, have a peculiar aspect. Mica of a very dark hornblendic green, or black colour, and remarkably brilliant metallic lustre prevails. Many of the specimens exhibit various degrees of alteration, and are more or less crystalline. The quartz, even in those approaching more nearly to the ordinary character of the schists, is not in the same regular and even laminæ, but in separate lumps or masses which are disposed in irregular layers, and produce, even in the most truly schistose specimens, a very uneven fracture. Schorl is not uncommon, and the talcose varieties of the schists are numerous in the southern portion of the Sheet. The majority of the rocks are distinctly gneissose.*

93. A green chloritic rock, with occasional small patches of carbonate of lime in thin irregular layers; felspar and quartz also in grains or lumps, while the mass of the rock is composed of green chloritic mica. Veining this are thin strings of quartz, and green talcose mica, of highly metallic lustre. 90. Very quartzose, with irregular layers of crystalline reddish felspar and mica. 91. Do., more laminar, less crystalline, with imbedded lumps of quartz, and associated with No. 92, a micaceous gneissose rock; the mica greenish-brown, and brilliantly metallic. 89. A chloritic gneiss, chiefly of chlorite mica and reddish felspar; quartz not abundant; felspar in crystalline plates; crystals of schorl frequent. In this occurs a vein of quartz, felspar, and chlorite. 87. Semi-crystalline, the brilliant fascets of the crystals being visible on the cross fracture: the felspar is red, the mica chiefly in continuous layers. 88. Very similar; more coloured by iron. 83. A talcose gneiss; quartz in small granular lumps, in junction with No. 82, a quartz-slate of the ordinary character; mica highly metallic. 94. Mica brilliant, and passing into chlorite. 59. Soft and reddish coloured; mica soft, and talcose in thin partings. 60. Do., quartz and mica, or talc, in thicker and more separate layers. 61, 62. Much altered and indurated; much iron-shot, the mass being a kind of hornstone, with numerous imbedded lumps of quartz, very similar to one variety of the rocks which occur on the east face of Slieve Gallion. 110, 111, 114. All of similar character, differing but very slightly in the relative proportion of ingredients; are all dark in colour, owing to the prevalence of black metallic mica; where exposed, passing into a deep rust colour; but rudely schistose. 113. A vein or seam of red felspar, chlorite, and quartz; the felspar appears crystalline, and imbedded in the chlorite, the quartz in strings or layers, and the chlorite in aggregated scales or plates. 115. Is similar, the ingredients more intermixed, and the rock more clayey. 141. Patches of the soft chloritic mica, with imbedded acicular crystals of schorl. 143. The schistose structure is only visible in a favorable fracture. 144. Laminæ beautifully curved, felspathic, with traces of schorl. 145. Very micaceous: mica soft, green, and clayey, with numerous small crystals of schorl; quartz in irregular strings, and felspar in imbedded crystalline portions: iron pyrites in minute quantities. 146. Mica of the same bright metallic lustre. 99. Mica of the same character, though lighter in colour. 98. Very dark in colour, owing to prevalence of mica; rudely schistose, like No. 110, &c. 116. Schistose

structure only apparent where the rock is weathered; the felspar appears crystalline, and the mica is only distinctly seen on the longitudinal fracture. 117. Black metallic mica very prevalent, giving the rock its peculiar dark colour and shining aspect. 118. Consisting of alternate layers of soft green talcose mica and quartz. 119. Similar; the mica and quartz not so regular in their lamination; laminæ much curved. 139. The same brilliant metallic mica abundant. 140. Do., with grains of felspar. 130. Soft clayey mica, greyish-green; quartz, and small portions of felspar. Veins of the same clayey mica, with imbedded crystals of felspar, strings of quartz, and iron pyrites. 132. The quartz and felspar in granular lumps; the mica in irregular plates; traces of iron pyrites. 133. Do., ingredients more separate. 134. Do., very similar to 132. 135. Mica very abundant, quartz in lumpish layers. 136. Thick layers of quartz, with partings of talcose light green mica; acicular crystals of schorl. 121. Of ordinary character, very quartzose; the mica still of the same black metallic lustre. 123. Chloritic; quartz only semi-vitreous, felspar not abundant. 122. Alternate irregular layers of quartz and of the highly metallic black mica. 125. Fine grained, and very slightly schistose, the schistose structure being only visible where weathered. 124. A close-grained, dark green, hornblendic schist, or schistose rock, the fibres of the hornblende being arranged with the lamination of the rock. In it are veins of a largely crystalline felspar, quartz, and chlorite, with angular grains of iron pyrites. 126. Mica highly metallic and soft. 127. Do., more abundant, laminæ curved. 128. Quartz and mica in thicker and more segregated layers. 148. The quartz and felspar in irregular crystalline layers or lumps; mica abundant and brilliant. 149. Mica with chlorite abundant, with crystalline imbedded masses of felspar and seams of quartz; crystals of schorl abundant. 150. More schistose; no schorl. 151. Schistose structure not observable on the cross fracture. Seams of micaceous talc-slate, with irregular seams of quartz, occur here, and No. 152 is a bed of similar slate. 154. Mica green and chloritic; quartz and felspar distinctly crystalline. 155. Ordinary hard quartz-slate; grains of iron pyrites and carbonate of lime disseminated. 157. Fine grained. 158. Of chlorite, quartz, and felspar; the two latter in distinct crystals. A granitic vein, mica, felspar, and quartz, with chlorite, occurs between 158 and 159. 159. Blackish-green chloritic mica abundant; iron pyrites. 159. At waterfall. More gneissose and coarser grained. 161. Thin layers of talcose green slate. 162. Gneissose, similar to 132, 158, 142, &c. 163. Green talc and quartz; the latter abundant, with iron pyrites in small grains. 164. Quartz abundant; mica light greyish-green. 147. Very quartzose, with traces of felspar. 120. Do., the schistose structure only visible on longitudinal fracture. Veins of a peculiar rock, formed of chloritic mica in aggregated plates or scales, with imbedded crystalline portions of felspar and quartz; iron pyrites also occurs disseminated; the mica is dark green. 76. Fine grained, schistose from plates of mica. 77. Very quartzose; a slight trace of felspar.

Sheet 44.—*The rocks of this Sheet have the same general character as those from Sheet* 40.

9. Hard, dark, flinty quartz rock, with occasional thin layers of mica. 20.

Very quarztose, with patches of reddish felspar. 4, 3, 2. Mica green and brilliant; quartz in granular lumps; felspar not abundant. 16. Very similar, but more quartzose. 19. Mica of the same brilliant character is more abundant. 24. Very micaceous; mica very brilliant; thin coatings of carbonate of lime on the cleavages. 21. Of the ordinary character. 1. Traces of hornblende, coarse grained. 10. Talcose, talc in irregular layers; carbonate of lime on the cleavages; minute grains of pyrites; felspar crystalline. 21. Ingredients crystalline, rock talcose, carbonate of lime abundant. 22. Mica, dark chloritic, forms by much the largest proportion of the rock, with imbedded crystalline portions of felspar and quartz in short irregular strings or masses. 24. Very similar, mica not quite so abundant. 29. A chlorite-slate; laminæ irregular and curved, and rough from mode of occurrence of the quartz; carbonate of lime, both disseminated and on the fissures. 12. A nearly homogeneous hard green clay-slate, with numerous crystalline grains of iron pyrites imbedded; carbonate of lime in thin strings and veins traversing the rock. 10. A dark blackish clay-slate, greatly curved and contorted; iron pyrites abundant; carbonate of lime in layers and seams. 15. Talc-slate; alternate layers of quartz and impure talc, with traces of felspar. 18. Very similar, decomposed, more gneissose. 6. Do., more talcose; quartz more segregated into thicker irregular layers, giving the rock a very rough lamination. 25. Do., talc more earthy and impure, more iron-shot. 26. Do., quartz not in layers, but in segregated masses; iron pyrites in numerous imbedded crystals. A vein of dark blackish clay-slate is found here. 13, 5. Talcose, quartz in lumpy layers, partings of brilliant metallic lustre. 4. Do., quartz in thin layers, and more equally distributed; rock, therefore, harder.

Sheet 45.—*Generally of precisely similar character to those of Sheets* 44 *and* 40, *as far as the schist rocks are concerned.*

1. Hornblendic rock, schistose; very quartzose, with stringy laminæ of fibrous green hornblende; small portions of carbonate of lime disseminated, and small grains of galena in patches. 3. Talcose; shining veins of the same substances in segregated portions or layers. 5. Chloritic, rudely schistose, with patches of crystallized carbonate of lime, and occasional thin layers of dark shining mica. 8. Like No. 3, but less schistose. 11. Jaspery iron quartz, with micaceous iron (specular iron) on cleavages, and in veins.

Sheets 40, 44, *and* 45.

Independently of the schist rocks, these Sheets afford a most interesting and instructive series of rocks of a distinctly metamorphic character, and are of especial interest, as placing beyond a doubt, the origin of the greenstones, and porphyritic greenstones of the eastern face of Slieve Gallion. The specimens from these Sheets are beautifully porphyritic, the paste being an uncrystalline mixture of greenish felspar and hornblende, with occasional strings of quartz; imbedded in which are numerous large and well pronounced crystals of hornblende.

Serpentine occurs associated with the paste of a similar light green colour; occasionally also reddish, in strings and patches, and numerous thin thread-like seams of the same substance, in greater purity than the mass of the paste, traverse the rock. In others the paste passes into a hard compact basis, having much the aspect of compact felspar of a light green colour. The imbedded crystals vary in size from large to acicular, and have a perfectly crystalline arrangement. The rock has not, however, lost its schistose structure, thin, interrupted but nearly continuous, laminæ or partings of coarse greenish-white talc being traceable; while in other cases it is a distinct talc-slate, only differing from the neighbouring varieties in having crystals of hornblende disseminated. Seams of carbonate of lime, coloured by iron, in some cases coat the cleavages.

These distinctly porphyritic rocks occur at Nos. 177, 178, 179, townland of Tullybrick, and No. 181, townland of Corick.

Associated with these rocks at No. 178, occurs a layer of hard compact rock, almost entirely felspar, with a few imbedded crystalline portions of quartz, and numerous perfect cubical crystals of iron pyrites.

Again, rocks precisely similar to the above porphyritic specimens, and with the same imbedded crystals of hornblende, are found at Nos. 43 and 34, in the townland of Brackagh, and, though not quite so well marked, in the townland of Straw Mountain, at No. 31.

But the most important fact with regard to these specimens is the perfect transition which can be traced into the ordinary talcose schists adjoining, with which they appear also to alternate. Thus at No. 176, "under 177," is a slaty rock, composed of alternate thin layers of quartz, and a light greenish talc with darker irregular spots or markings, and on a careful examination it will be observed that these darker portions are only imperfectly formed portions of hornblende.

Similar rocks, less altered, are seen at No. 170. Carbonate of lime occurs here in thin layers, and the slate is of a much more uniform colour. Still more slaty, and even fibrous, at No. 169, minute crystals of iron pyrites occurring in these varieties. At No. 175 is a layer composed of irregular laminæ of semi-crystalline quartz, with numerous small perfect crystals of iron pyrites, parted by thin seams of light greenish-white talc.

These last two varieties are also seen in the townland of Corick, in connection with No. 181; at 189, 183, in connection with Nos. 43, 44; at No. 45, in connection with No. 31; at 48, 42, 32, 33, 30, 39, and 37; while intermediate varieties, resulting obviously from original differences in the constitution of the beds, occur at No. 34, a spotted, reddish coloured compact felspar, with serpentine. 35. A granitic rock, still, however, schistose, with abundance of iron pyrites. 36. Nearly quartz; thin partings of a greenish talcose substance; pyrites. 46, townland of Brackagh, is similar to No. 35. 170, Moyard, nearly so. At No. 165, 166, 167, there are rocks similar to No. 175, the carbonate of lime occurring both in thin minute strings, and also in thin coatings on the fissures. 190. Is nearly similar; quartz more collected, into crystalline portions. Again, at No. 41, townland of Corick, and 50, townland of Straw Mountain, are rocks nearly identical with Nos. 35 and 46.

Specimens of precisely similar composition and character are found at Nos. 84, 85, 86, townland of Tullybrick; and in the same townland at Nos. 64, 65, 66, 67, 68, 69. Similar rocks also occur in Sheet 44, at No. 29, and in Sheet 45, at Nos. 1 and 5.

Note on the practical application of Ochres, see page 173.

The price of ochre in the Dublin market is £6 per ton, or by the cwt. 12s. The following particulars respecting ochres, from the "Traité de Chimic appliquée aux Arts" of Dumas, are deserving of attention:—"Ochres are either per-oxide of iron, or hydrated per-oxide of iron, mixed with a large quantity of clay or marl. Red ochre contains the per-oxide, yellow the hydrate of the per-oxide, brown ochre a mixture of the hydrates of the per-oxides of iron and manganese. 'La sanguine ou crayon rouge' is an example of the first variety, or red ochre; it has a schistose structure, and is found in the midst of the clay-slates. M. Lomet has proposed to wash the 'sanguine' by decantation, in order to separate all the larger grains, and to mix the fine paste subsequently deposited with gum water. This being evaporated to the proper consistency, is moulded into crayons and dried in the shade. The proportions of the mixture are—

Sanguine.		Gum Arabic.	
1000	—	31	very soft, fitted, however, for bold outlines.
1000	—	36	rather soft, excellent for ditto.
1000	—	42	soft and solid, for common use.
1000	—	47	moderately firm, for delicate objects.
1000	—	52	very firm, for the finer touches.
1000	—	62	of Isinglass, excellent.

Red ochre is seldom found in nature, but is usually prepared by calcination from the yellow. The ochre of Pourrain, near Auxerre, contains 12·4 per cent. of per-oxide, with 7·6 of water. It is worked with great ease; the ochre is extracted, mixed with water, decanted, and left to settle. By the decantation, all the larger grains are separated, and the ochre is deposited as a paste in the pits where it is allowed to settle. It is dried, pulverised, and is then fit for market. To obtain the red ochre, the yellow previously washed is heated in a reverberatory furnace until it has acquired the desired tint. The process, therefore, is similar to the one recommended at page 174.

For the following description of the ochres used in Scotland, I am indebted to Major Downes of Edinburgh:—The ochre used for water colour painting on walls, and also by paper-stainers in Scotland, is procured from Leven, a small village at the mouth of the river Leven, which runs into the Bay of Largo in the Frith of Forth, about twenty miles N. E. of Edinburgh, on the Fifeshire coast. At the small village of Easter Wemyss, about three miles west from Leven, the ochre is also found, but of an inferior quality. The Leven ochre is sold at £4 per ton when prepared fit for use in powder, and the Wemyss ochre at £3 per ton; it is packed in casks of about 7 cwt., and sold by the cwt. at from 5*s.* 6*d.* to 7*s.* 6*d.*, according to its quality, and retailed in the shops at 3*d.* per pound. The ochre is on the estate of Captain Wemyss, and is worked by Mr. Anderson; it is found above the coal, and in some places about ten feet below the level of the surface. It is raised in flakes, and ground in water by a water mill, then washed and passed through various receivers, in which are deposited the sand and gritty particles, whilst the ochre is suspended in the water, until at length it is allowed to settle; it is then dried and pounded in the mill, and packed into casks of any size required. Coal abounds all along this part of the coast of Fife where the ochre is found. Ochre has been found in a very pure state at Woodhall, four miles west of Edinburgh, and also at Dryden, near Roslyn, six miles S. W. of Edinburgh: it was formerly procured at Alloa, farther up the Frith of Forth, (five miles below Stirling), where there are most extensive coal works, but the ochre from Alloa is not now used: it is also found in Ayrshire.

The ochre got at Leven is of a brighter yellow, and has less iron in it than that procured at Easter Wemyss, and is preferred on that account; and it may be added, that the ochre of Bitry, in the Départment de la Nievre, is said to contain, when calcined, only 3 per cent. of per-oxide of iron.

CHAPTER VIII.

SIMPLE MINERALS.

It was my original intention to have placed this chapter in succession to that describing the metamorphic rocks of Slieve Gallion, and the syenitic range with which they are in contact; but as some of the most remarkable of those rocks, and the most striking changes and passages which they demonstrate, are intimately connected with the sandstones of the old and new red systems, both at Slieve Gallion and at the analogous locality of Cushendall, in Antrim, I have thought it better to place the chapter describing them after that which will treat of the sandstones. The list itself, though not confined to the minerals of the basalt, contains a rich collection of them, and is, therefore, supplementary to the history of that most interesting rock; but though it may be considered tolerably copious, there are other species not here noticed, their composition being at present unknown, and, without doubt, more may yet be detected in the numerous specimens of the collection. Originally I had hoped to advance still farther this interesting branch of research, by chemically examining the composition of all those species on which doubt, with some reason, still rests as having been probably formed from the analysis of compounds rather than of simple bodies. To prepare, however, for such a series of analyses, it was first necessary to have the abundant specimens of our collection carefully and mineralogically examined, which of itself was the work of time; to have pure and perfect specimens selected from them, so as to avoid the chances of those errors suspected to have occurred—errors which, except in an extensive collection, were almost unavoidable; and to arrange them in such suites as would bring out their peculiarities, and decide their rank as species or varieties. This has been done with great zeal, care, and industry, by Mr. Oldham, who has had the further and great advantage of comparing the specimens with the original minerals analyzed and described by Dr. Thomson, and with those in the fine collection of Professor Jameson, and of benefiting by the cordial assistance of those eminent mineralogists; and should these inquiries be ever resumed in the County of Antrim, a proper foundation has been laid for the chemical examination of the basaltic minerals—one, which acting on specimens obtained not from distant, but from the same localities, would bring out new facts respecting the grouping of these interesting minerals, and throw a new light on the circumstances and laws which have regulated their composition and induced their variety. Mr. Oldham justly observes, " that greater benefit would be conferred on mineralogy by such relative analysis of a connected series of minerals, than by the determination of new species, however interesting, or the examination of single specimens, however important. Thus, who can define the limits, as species, of Lime-chabasie, Soda-chabasie, Hydrolite, and Levyne, now considered distinct, or how can the confusion be removed, save by a careful examination of the entire suite ?" I would add, conducted with a knowledge of all the peculiarities of their position, of the changes produced by decomposition, and of the relations existing between the included minerals and the matrix containing them. These considerations, connected with the variations in the physical characters of hardness, opacity, or transparency, and, generally, of crystallization, would have invested this branch of the subject with a high philosophical interest, which I think may yet be shed upon it. The list itself has been drawn up principally on the plan of Phillips' Mineralogy by Allan, as a well-known popular work; the Zeolites, however, being arranged according to that of Dr. Thomson's Mineralogy, on account of the new species created by that author, many of them from Irish specimens; and it does not, therefore, enter on the subject of classification, either to discuss its defects, or to suggest improvements.

QUARTZ

Is of universal occurrence throughout this district, forming an ingredient in most of the rocks. In the mica schist, disseminated in small grains and semi-crystalline masses; in veins, massive and crystalline, commonly associated with felspar and chlorite, and frequently of a brown colour; in the gneissose rocks of Derry, in small imbedded lumps, semi-translucent, and of a pale celestine blue colour. As quartz rock, in thin beds, subordinate to the mica schist.

ROCK CRYSTAL

Is found abundantly in the parishes of Dungiven, Banagher, and Cumber, in large crystals, frequently of brown, smoke grey, and yellowish colour, (Benedy Glen, Dairt, &c.) These remarkable crystals are found imbedded in the soil of the country, and have not yet been traced to their source. The greater number are much worn and rounded, while others are beautifully perfect—the edges of the prisms and summits of the pyramids being uninjured. They are commonly known as "Dungiven crystals." Similarly it occurs in the parishes of Donaghmore and Tullyniskan, County of Tyrone. In small transparent colourless crystals, forming drusy coatings in the cavities of the remarkable magnesian beds in the chalk at Donald's Hill (see page 111), generally disposed in flat columnar radiated crystals, occasionally large and distinct. The form $\frac{P}{2}\ P + \infty$ of Mohs, three-sided pyramids on six-sided prisms, is not uncommon here. At the same locality it occurs similarly in a soft amygdaloidal claystone, being the only instance of crystals of quartz in the basaltic rocks which we have met with. In cavities of the flints and chalk it frequently is found lining the hollow casts of shells, and coating the fissures in small brilliant crystals. In minute crystals of a bright reddish-yellow colour, with iron flint, at Benbradagh. The large crystals were supposed to occur in the "Trap Rocks," and it has been stated that "some occur in the debris of the mountains of the basaltic range, but have most probably been transported thither by currents from the primitive country to the west, small crystals of quartz, however, being frequent in the trap rocks." Neither statement has been, as yet, verified, rolled crystals of quartz not having been met in the debris, properly so called, of the basaltic range.

HYALITE

Occurs in great beauty at Donald's Hill, forming a mammillated coating, consisting of concentric layers, in the cavities of a soft claystone amygdaloid, disposed on an ochraceous earthy mineral, in concentric crusts. The hyalite itself is frequently studded with small dentiform crystals of arragonite. Hyalite has been said to occur in the granite of Mourne, but erroneously. Sir C. Gieseckè gives the Causeway as a locality; but though it may probably occur there, the Ordnance Collectors have not met with it, nor has it been observed anywhere but at Donald's Hill. This is, therefore, the first authentic British locality of this mineral.

OPAL.

Common opal occurs, filling the cavities of amygdaloidal greenstone at the Causeway; Rathlin Island; Crossreagh, parish of Ballywillin, and in several places along the basaltic range, principally white, varying from translucent on the edges to opaque; also striped, and sometimes yellowish.

At Sandy Braes (Connor parish, County Antrim) it is met in great abundance, forming strings or irregular veins in the pitchstone porphyry of that district, generally opaque and white; also yellow, or reddish yellow, and highly translucent, having much the aspect of the coarser varieties of amber. Occasionally it presents considerable play of colours; associated with it, but sparingly, jasper-opal is found.

HYDROPHANE is found at the Causeway in small roundish masses in amygdaloid, of a brownish-white colour, much like Mountain Cork. Also at Crossreagh, parish of Ballywillin.

FLINT

Abundant along the chalk escarpment. It occurs principally in regular layers (at an average distance of about three feet); general colour, blackish-grey; also found yellow and red near the contact of the trap rocks with the chalk; of a delicate rose-pink at Carnowry, Magilligan; and at Donald's Hill; not unfrequently striped in lines parallel to the outer surface. The flints are commonly cavernous, the cavities being generally the casts of organic remains and lined with drusy crystals of quartz. The fossils themselves are frequently preserved in carbonate of lime.

Near the junction of the chalk and trap rocks, the flints present commonly a curious and remarkably shattered appearance, having apparently been fractured into small pieces, which have been again united, the union sometimes taking place without any intervening cement, and at others exhibiting a siliceous breccia of angular fragments.

CHERT occurs in beds in the carboniferous limestone at Stewartstown, Donaghmore, Drumglass, &c., &c., County Tyrone. Similarly in County Fermanagh, &c., of a light ash grey colour.

The ferruginous flint of the dealers is common in the gravel.

CALCEDONY

Not common; of a whitish grey colour, forming mammillated coatings in the cavities of the rocks at the junction of the trap and chalk, disposed on pearl spar, at Smulgedon, near Dungiven; at Cloghan, parish of Balteagh; the White Mountain; at Slieve Gallion Carn, &c.,

and of a blue tint, having its surface coated with minute crystals of quartz at Knocklayd, County of Antrim.

THE CACHOLONG variety occurs associated with it at Smulgedon: in thin mammillary coatings lining the cavities of the compact felspathic and porphyritic rocks of Barrack Mountain, parish of Pomeroy. Similarly in the parish of Clogher, County Tyrone.

ONYX is found filling small cavities in amygdaloid at the Causeway, and at Rathlin Island, striped white and yellowish-brown. Also frequent on the shores of Lough Neagh.

CORNELIAN occurs only as pebbles in the gravel of Lough Neagh, where also *Agates* and *Heliotrope* are found, though not of any beauty.

JASPER

Not uncommon; small pebbles are found in the old conglomerates of Bovevagh and Banagher; of a deep red colour at Slieve Gallion Base; associated with iron flint and micaceous iron, at Tullybrick, parish of Ballynascreen. In abundance in the older conglomerates of Tyrone. Very abundant in the Cushendall porphyry.

GARNET.

Looking at the Geological Map of this district, it would naturally be expected that garnet would be by no means an uncommon mineral; but it is remarkable that, throughout the whole County, there are only two or three localities where it has been observed,* and there in minute quantity. In the County of Donegal, common garnets occur in rhombic dodecahedrons of some size, in the parish of Templecarn, imbedded in a talcose mica-slate.

ZOISITE

In fine crystals of a greyish brown or olive colour, in greenstone-slate, at Hollyhill, near Strabane, County Tyrone.

EPIDOTE

In small quantities, massive, and shooting into crystals, of a lightish green colour, occurs, coating the cleavages of the syenitic rocks of Slieve Gallion, Kildress, &c.; also in thin strings, or veins passing through the rock. In veins at Tor Head, County Antrim, associated with quartz and red felspar; granular and coarse, forming veins in the hornblendic rocks at Termon townland, parish of Termonmaguirk, similarly at Tieverah Mountain, County of Antrim.

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* An equally remarkable fact, with regard to the great trap district, is that, notwithstanding its exceeding richness in minerals, a single specimen of Prehnite has not been obtained, nor is it certain that it has been found in Ireland. We lately saw a specimen of this mineral, said to be from the County of Down; but under circumstances which rendered the fact very doubtful. Sir C. Giesecké gives Down Hill as a locality, but that neighbourhood was very carefully examined for it, and without success. The Miemite has sometimes been mistaken for Prehnite, which it much resembles in the mode of aggregation and colour.

LITHOMARGE

Of greenish-white colour, highly indurated, in masses, in the trap rocks at Dunluce; similarly at Port Bradden, Ballintoy, and at Salough Braes, near Larne. An indurated variety of Fuller's Earth is found near Ballycastle, in small quantity.

BOLE

Is very common, forming irregular beds or layers in the trap rocks, generally of a deep red colour often spotted with yellow; of bright vermillion red with spheroidal concretionary structure at Down Hill, (Plinthite of Thomson); flesh red at Aghanloo; extends throughout the whole range.

AUGITE

Occurs in large distinct crystals of black and greenish-black colour in the cavities of the augitic rock at Portrush, coated by, and associated with, Mesole. Similarly at Fair Head, and in larger, but more irregular crystals; also at Agnew's Hill, parish of Kilwaughter, County of Antrim. Massive in the same rocks, in large lamellar and slightly granular concretions; disseminated and as an ingredient in the crystalline basalts; associated with Olivine in a largely crystalline greenstone dike at Tullyreagh, parish of Artrea. Similarly at Culfeightrin, Tor Head; and Ramoan, County Antrim. Also in the remarkable dike near Clogher, County Tyrone. Thomson states Hardness = 4·75; our specimens are fully 6·0; that from Portrush, lighter in colour, is 5·5—5·75.

HORNBLENDE,

Not unfrequent as an ingredient in subordinate beds of the mica schist district; also in veins in the same rocks, associated with milky quartz and reddish felspar; as a constituent of the highly crystalline syenitic rocks of Lissan, Pomeroy, and Kildress parishes, and in large distinct crystals imbedded in the altered porphyritic rocks of Slieve Gallion, Windy Castle, Ballynascreen, &c. Basaltic hornblende, in small crystalline grains, is a frequent ingredient in the more highly crystalline basalts, as at Down Hill, Causeway, Magilligan, &c.

ACTYNOLITE

Is scarcely met with, though traces of it are observed in some beds, subordinate to the mica schist.

Asbestiform Actynolite is found at Prehen, near Derry, in the rifts of a greenstone-slate.

Asbestus, of a greenish-grey colour, is found similarly at Holly Hill, near Strabane, (rare), accompanied by *Amianthus.*

Mountain Leather is associated with the chalk at Slieve Gallion, in thin plates of a dirty yellowish-white colour. Similarly at Coagh; and at Curly Burn, Aghanloo.

HYPERSTHENE,

Dark green or blackish-grey in colour, and having a strong semi-metallic lustre, occurs in crystalline concretions of some size at Athenry, parish of Termonmaguirk, and at Craigs, parish of Derryloran, County Tyrone. It passes into a greyish-green diallage, and, with a greenish felspar, forms the very beautiful diallage rock of those localities. This is the first Irish locality of Hypersthene. It occurs also precisely similar in the Isle of Sky, (MacCulloch,) and in Radnorshire, (Murch. Sil. Sys., page 318.)

BRONZITE (?)

Occurs in small lamellæ of bright colour in amygdaloidal greenstone at Benyevenagh, Magilligan, and in minute quantities at several places in the basaltic area.

STAUROLITE

Is not uncommon in small six-sided prisms in the talcose slates of the lower member of the mica schist district.

CHRYSOLITE.

Small crystals occur in the crystalline trap rocks of the Causeway, and are occasionally observed all along the basaltic range.

OLIVINE

Is frequent in disseminated uncrystalline small masses in the greenstones, of olive green, oil green, and brownish colour; in larger indistinct individuals in basalt at Drumachose; associated with massive Augite at Fair Head; in minute uncrystalline grains at Ballintoy; and abundant in small disseminated particles at Agnew's Hill. From partial decomposition, it has here a very highly metallic lustre. Of a fine cherry-red colour, and translucent, at Island Magee, in large crystalline concretions.

SERPENTINE

Occurs in small quantity, forming a coating on the fissures, and in thin strings, which traverse the rock in the metamorphic hornblendic rocks of Slieve Gallion and Kildress, and in some of the beds of hornblende-slate subordinate to the mica schists.

MICA

Is of general occurrence.

THE LEPIDOLITE

Is found in small plates of a dull pink colour in the granitic rocks, near Athenry, parish of Termonmaguirk, County of Tyrone, and rarely in some of the clayey beds of the mica schist, as at Benedy Glen, Dairt, &c. Similarly also, of a whitish colour, at Holly Hill, near Strabane.

FELSPAR,

As an ingredient in the composition of the rocks, is universal; as a vein stone, very common in the primary rocks; generally of a reddish colour. At Lime Hills Pomeroy, County Tyrone, it forms one of the ingredients in the remarkable rocks which occur there. It is rarely in crystals.

GLASSY FELSPAR is common in distinct imbedded crystals, in the trachytic porphyries of Antrim and Down.

ALBITE,

Finely crystallized, associated with zoisite, at Holly Hill, County Tyrone; in distinct crystals, imbedded in greenstone porphyry, at Ballycastle; and general, as a component of the greenstones.

Small crystals of LABRADORITE occur in the greenstone porphyry of Ballycastle, County of Antrim, occasionally presenting a slight play of colours.

CHLORITE,

A not uncommon ingredient in the rocks in the mica schist district; in veins, common, associated with quartz and felspar.

GREEN EARTH is common, lining the cavities in amygdaloid throughout the basaltic range.

OBSIDIAN,

Velvet black, in the vesicular cavities of fine-grained greenstone, at the Causeway, rare; occasionally also at Craigahulliar, near Portrush. A highly vesicular porous rock, nearly allied to pumice, is met with at the Causeway.

PITCHSTONE

Is abundant in the porphyry of Sandy Braes, in the County of Antrim, accompanied also by PEARLSTONE.

TOURMALINE.

Schorl is frequent in the mica schists, in long acicular and curved crystals, as at Sawel, Dairt, Benedy, Spelhoagh, &c., &c. The crystals are generally arranged on the laminæ of the schists; but frequently also they cross the lamination, and are much curved. In veins it is common, associated with quartz.*

ALUMINITE

Occurs in thin seams, earthy, at Portrush in the fissures of the greenstone, disposed on calc-spar; rare.

SULPHATE OF ALUMINA

Occurs in efflorescences on the slate clay at Coal Island, Drumglass, Ballycastle, &c., and in the lias, Ballintoy.

CARBONATE OF LIME,

Universal, occurring in every variety of rock in the district. At Donald's Hill, townland of Cloghan, it occurs in well-marked rhombs, implanted on pearl spar; at Slieve Gallion, in the chalk, in thin tables crossing each other, externally of a red tinge; also in fine six-sided modified prisms.. In the carboniferous limestone of Derry and Tyrone, veins of calc-spar are frequent, and it presents very numerous forms of crystallization; is generally of a greyish-white colour, but also yellowish and greenish. Common in the trap rocks in prismatic, rhomboidal, and dentiform crystals, generally of a yellow colour. At Magilligan and Portstewart, in aggregated rhomboidal crystals, having a peculiar oily lustre; at Ballintoy and the Causeway, of a rich orange-yellow colour, and highly translucent (known to the guides as "Sugar Candy Stone"); at Tickmacrevan, in large crystalline masses in chalk, here replacing flints, and assuming all their shapes; sometimes also, though rarely, enclosing fossils (Belemnites.) As calc tuff, it is of very frequent occurrence throughout the primary and secondary district.

Agaric Mineral occurs in thin seams and veins in the new red sandstone, Curly Burn, Aghanloo, and investing the cavities of flint balls at Slieve Gallion Carn, and occasionally along the chalk range.

ARRAGONITE

Is found in minute filiform crystals shooting across the cavities of basalt and amygdaloid in several places. At Down Hill, of a rose pink shade, translucent, in radiated masses in a soft wacke; also of pure white, accompanied by crystals of calc-spar; also yellowish-grey; also in silky fibres in thin seams (satin spar); similarly at Benbradagh, Dungiven. At Magilligan, in radiated crystalline masses of a deep rust colour; also of a clear rose pink; similarly at Aghanloo. At

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* The *Indicolite*, of a fine blue colour, occurs in the granite of Donegal.

Ballintoy, of a fine oil green, or greenish-white colour, associated with Antrimolite. At Dungiven and Benyevenagh, in dense greenstone, it occurs in stellated groups, forming a thin coating on the fissures of the rock. At Portrush, it occurs similarly on the indurated rocks (rare.)

The "Flosferri" variety occurs very well marked at the Black Path, Down Hill.

BITTER SPAR, OR BROWN SPAR,

Occurs in small, but well-defined crystals, in the cavities of the nodules of impure limestone, which occur in the marls of the sandstone, at Dungiven, Banagher, Bovevagh, &c.; similarly in Ballynascreen. As pearl spar, it is abundant in the remarkable beds at Cloghan, Donald's Hill; at Down Hill, associated with the hydrocarbonate of magnesia and lime; in the limestone of Desertmartin, of various shades, from yellowish-brown to rich straw yellow, and with high pearly lustre.

MIEMITE

Of a rich yellowish-green, or oil yellow colour, crystallized, and also in globules of a dark olive green colour, and having no traces of crystalline structure, implanted on pearl spar, at Donald's Hill.

GYPSUM

Has, in the County of Derry, only been observed in rolled lumps in Ballintemple Glen, parish of Errigal, probably derived from the small patch of new red marls which occur in that neighbourhood, though it was not observed *in situ.* In Antrim it is abundant.

SELENITE, in flat crystals of greyish colour disseminated in the slate clay at Benburb, also accompanying the fibrous Gypsum, in Antrim.

NITRATE OF LIME

Is found in efflorescences, in caves, and on old walls, common.

FLUOR SPAR

Has not been noticed in this district, nor is it at present known to occur in the trap rocks, though crystals of the primary form of Apophyllite, sometimes coated with a thin crust, have been mistaken for it.

WOLLASTONITE (?) (of Thomson).

Small tufts of this mineral have been found at Portrush, accompanying Stilbite in greenstone.

MAGNESITE (Thomson, vol. 1, p. 178.)

A mineral (see page 115) occurs in contact with the trap dike at

Coagh quarries, possessing very much the character of this species. While moist, it forms a soft paste, which soils, but on drying it becomes hard and tough.

A curious mineral occurs in a soft amygdaloid at Down Hill. It is oolitic in structure, consisting of spheroids, cemented either by pure white carbonate of lime, or by green earth. In the latter case it has much the appearance of puddingstone. The spheroids are yellow, whitish, or greenish, and appear to be a mixture of the hydrocarbonates of lime and magnesia; the small cavities are lined with drusy crystals of pure white carbonate of lime; where exposed the cement yielding first, it assumes a mammillated appearance.

SULPHATE OF BARYTES

Is not uncommon; as a vein stone, frequent in the old red sandstone, forming thick veins, as at Ballynascreen; Slieve Gallion Base (parish of Desertlyn); near Clogher, County Tyrone, &c.; generally of a deep reddish or pinkish colour.

STRONTIANITE has not been observed in Ireland, but the greenish Arragonite of Ballintoy, and the brownish Arragonite of Down Hill both contain a sensible amount of Strontian.

STELLITE (?) (Thomson.)

A single specimen of this variety was procured in 1841, at Portrush, coating the fissures of the greenstone. The specimen is in a private collection. The species is, however, by no means well defined.

THOMSONITE.

This species is rarely met in Irish trap, and only in indistinct small crystals. It thus occurs in small radiating crystals in the cavities of basalt at the Causeway. Similarly at Island Magee; at N.W. of Rathlin Island, near the Bull, disposed on transparent Analcime. An amorphous brown mineral, stated by Dr. Thomson to be a variety of this species, is found in amygdaloid, near Ballymoney, County Antrim.

THE SCOULERITE variety occurs, rarely, at Portrush in small spheres, consisting of needles radiating from a centre; colour white, with a tinge of yellow; hardness about 4. (See Phil. Mag., December, 1840.) Differs from Thomsonite in containing less alumina and water, and in having about $6\frac{1}{3}$ per cent. of soda. Though there can be little doubt that a future and detailed analysis of this and the succeeding species will introduce several changes in their classification, still, as the species is at present considered well defined, the following may be stated as obvious characters by which it can readily be recognised, and the knowledge of its localities extended. It is very similar to, and frequently confounded with, Mesolite. It differs, however, 1st, in lustre, being pearly, or vitreo-pearly, Mesolite vitreous; 2nd, Thomsonite has equal lustre throughout, not so Mesolite; 3rd, Thomsonite is *always cracked across the crystals;* and 4th, is but slightly cohesive. It differs also in crystalline form, and very rarely has terminal planes. In radiation and colour, they are alike.

These distinctions refer to Thomsonite in a pure state, when its colour is white; but, independently of the amorphous variety mentioned above, Thomsonite occurs in several forms, differing much from its normal character. Thus at Magilligan and Down Hill, (Scoulerite,) it is found in spherical globules, externally of a brownish-white colour, but internally of a reddish-brown, consisting of fine fibrous crystals radiating from a centre. These pass by gradations, perfectly insensible to the eye, into compact. See the remarks on Chalilite; and it is not improbable that these two minerals are only separate forms of one and the same species, differing principally in the amount of iron contained; a difference which, in earthy minerals, cannot be considered a sufficient ground for specific distinction.

NATROLITE

Is a common mineral in the trap rocks. At Island Magee, in large and beautiful crystals, transparent, aggregated in radiating masses; also in white translucent acicular crystals; and in delicately fibrous crystals lining the cavities of amygdaloid, frequently tinged of a reddish hue. At Portrush, in minute crystals shooting across the cavities of the greenstone, also forming a coating on crystals of carbonate of lime, and bearing its impressed forms. At Portstewart, in distinct and well pronounced crystals, forming radiating masses, implanted on Analcime. Similarly in great beauty at Down Hill. At Magilligan, in minute acicular silky fibres, so delicate as to be driven by the slightest breath, in the cavities of amygdaloid; forming stalactitic looking masses, as coatings to long crystals of carbonate of lime; of a light rose red colour, and occasionally of a straw yellow, associated with Levyne; in acicular single crystals, associated with Mesole, crossing the small cavities in amygdaloidal greenstone; on these delicate fibres are implanted small rhombic crystals of carbonate of lime, strung like beads on silk: frequently a larger crystal of Mesotype will cross the cavity, and on it, and radiating from it, will be observed numerous minute fibres of the same mineral. E. of Down Hill it occurs (? Mesolite) in well marked radiating crystals, filling large cavities in greenstone, generally pure white, but also of rust colour, light reddish, and greenish; in many of the cavities the crystals occur beautifully interlaced. It is common all along the basaltic range, generally occurring in exceedingly minute fibres; these occur in great beauty at Craignashoke, associated with Levyne and Analcime. Compact—it occurs at Down Hill in amygdaloidal greenstone, white, and semi-translucent. At Portrush, snow white, or brownish-white, opaque, and devoid of lustre, forming thin veins or seams at the junction of the greenstone and indurated shales; structure is fibrous radiated. At Little Deer Park, Glenarm, County Antrim, Mesotype occurs in small snow-white silky crystals, shooting across or filling tubular cavities in amygdaloidal claystone. These cavities are not of the ordinary character of those in amygdaloid, but form long tubes or pipes, frequently branching off on either side, and having much the appearance of being caused by boring shells. They are more probably the result of the ascent of air bubbles; a drusy coating of Chabazite lines them, on which the Mesolite is implanted in small radiating thistle-like forms.

Natrolite, externally of a beautiful straw-yellow colour, in minute aggregated crystals, is found rarely at the Causeway.

SCOLEZITE.

In many of the localities given above for Natrolite, Scolezite also occurs. Indeed the great confusion, which attends the several varieties, Natrolite, Mesotype, Mesolite, Scolezite, renders it a matter of no ordinary difficulty satisfactorily to assign limits to each. That Mesolite should be classed with Mesotype, and both arranged under the common name of Natrolite, is, we think, nearly established; and if this reduction of all the varieties to the two great classes of Natrolite and Scolezite, the one being characterized by the presence of soda, the other by that of lime, were adopted, the blow-pipe would at once afford a ready means of distinguishing them, by the comparative ease, with which they fuse with borax. Scolezite occurs also at Magilligan of a cream-white colour, associated with prehnitiform Stilbite; also of a pink-red, and brick-red, very compact. It appears made up of a congeries of minute globules of radiating crystals, so closely aggregated that each globule seems to run into the adjoining. Similarly at Aghanloo, also of an oil green colour; at Portstewart, very compact, having but slight traces of crystallization, both brick-red and whitish (? Mesotype crocalite of Brongniart). In all cases it contains small cavities coated by fine filiform crystals of the same mineral..

PLINTHITE

Is not an uncommon mineral, occurring in the softer varieties of the trap rocks, associated with the ordinary red bole of which it appears to be only a variety, and not deserving of being considered a distinct species.

CHALILITE.

Common, in irregular strings, passing vertically through the trap rocks where they rest on the porphyry of the Sandy Braes district in County Antrim. It is also found (rarely) at Magilligan, very compact, and at Down Hill. The cavities of the mineral are, in all these cases, crossed by numerous thin plates of the mineral, on which are disposed small reniform globules; these are in some cases compact, but frequently also fibrous and radiating from the centre of the globule; the thin plates are themselves also sometimes fibrous, being formed of two thin layers, which are both finely fibrous transversely (like satin spar). The Ordnance collection contains a very beautiful series of specimens, showing every variety of this mineral and its nearest congeners, and we doubt not, will afford on a future analysis, some interesting results. (See remarks on THOMSONITE).

ANTRIMOLITE

Occurs at Ballintoy, investing long pyramidal crystals of yellow carbonate of lime, also disposed on chabasie, lining large cavities in a soft clayey amygdaloid. The surface of the Antrimolite is frequently studded with rhombs of calc-spar, of brown and bright yellow colours, which contrast beautifully with the snowy whiteness of the Antrimolite. It appears exceedingly doubtful whether this can be considered a distinct species. Its hardness is much higher than stated by Dr. Thomson; but owing to the easy separation of the individuals, it is not easily ascertained. It occurs also at the Causeway, in a similar rock.

HARRINGTONITE

Forms veins or layers in the finer varieties of the greenstone of Portrush, and especially of the Skerries; it occurs also in a similar rock at Island Magee and Agnew's Hill; in the latter place rare.

SOAPSTONE, STEATITE

Occurs commonly in all the amygdaloidal rocks in small masses, filling the cavities; generally of a yellowish or brownish-white, also green, (and when fresh somewhat translucent, becomes opaque and harder on exposure); at Magilligan it invests long crystals of calc-spar, which have frequently disappeared leaving a hollow tube; a variety of light cobalt blue colour, occurs at the Craigs, Magilligan, associated with Levyne.

LAUMONITE

Has only been observed at Portrush, and is there very rare. Sir C. Giesecké gives Down Hill as a locality; and it has also been said to occur in the granite of the Mourne Mountains, but we believe incorrectly. The mineral mistaken for it will, it is probable, be found to be a variety of Stilbite, having magnesia as a component.

CHABAZITE.

Very common; extending throughout all the basaltic area, and appearing in almost every layer. The finest crystals have been observed at Portrush, very large and nearly transparent; similarly at Magilligan. In smaller crystals, at Benbradagh, Craignashoke, Slieve Gallion Carn, &c.; crystals frequently tinged externally reddish or yellowish; at the Causeway and Ballintoy, in large translucent white crystals, covered with Antrimolite; near the Bull, Rathlin Island, in aggregated crystals, covering pyramids of carbonate of lime; at Island Magee, of a light flesh-red colour; at Salough Braes, Larne, in beautiful transparent crystals of bluish-white colour, in the cavities of a ferruginous amygdaloid.

The soda variety of Thomson, is not uncommon, being observed in abundance at Portstewart, very well marked, investing the cavities of greenstone; similarly at the Causeway; also at Magilligan and Craignashoke. Dr. Thomson (Phil. Mag., Dec., 1840) gives Portrush as the locality, but we have not noticed it there. He also states (Mineralogy, Vol. i. page 334,) that Chabasie is "easily soluble in muriatic acid," which is contrary to the experience of other mineralogists. The distinction between the Soda-Chabasie of Thomson, and Hydrolite, appears to be evanescent.—(See Phil. Mag., Vol. x. page 278; and August, 1840, page 105).

LEVYNE,

Of the ordinary form of crystals, at Magilligan Carnowry, yellowish-white and opaque, in the small cavities of amygdaloidal greenstone; at Benyevenagh, greenish-white and translucent; at Cabragh, Termoneeny parish; at Cluntygeeragh, Dungiven; at Island Magee, of a yellowish-white or light flesh-red. But besides the ordinary form, Levyne (? Phakolite) occurs in double six-sided prisms, united by the base, highly modified. Of this form it occurs in splendid crystals at the Castle Rocks, Magilligan, greyish-white and translucent, also of a pinkish tint; frequently has minute crystals of Analcime implanted, and is studded with fibrous radiating groups of Natrolite often of a rich orange colour. In similar form and rocks at Portstewart; in both cases associated with, and disposed on a mineral which occurs in slightly mammillated coatings of a light greyish blue colour, having a soapy feel, and soft, yielding easily to the nail; appears to be a variety of Steatite; also at Portstewart, in dense greenstone.

In similar form of crystals, it is found at Craignashoke, Slieve

Gallion Carn, and at Cluntygeeragh, Dungiven; at Craignashoke, accompanied by delicately fibrous Natrolite, of a light pink colour.

The peculiar form, and splendid distinctness of the Magilligan and Portstewart crystals, render this a very beautiful variety. The crystallographic identity of these highly modified crystals with Chabasie, has been proved by Mr. Brooke.—(Phil. Mag., Vol. xi., page 12).

ANALCIME

Is of common occurrence in the Irish trap, and presents many varieties. It is ordinarily translucent and of a greyish-white colour. At Craignashoke, parish of Ballinascreen, it is found in large yellowish-white crystals, opaque, in amygdaloidal claystone. Similarly at Slieve Gallion Carn, and in great abundance in the County Antrim, at Layd; Tickmacrevan; Deer Park, Glenarm, &c. *Translucent*, at Dunluce, with implanted carbonate of lime, and associated with green earth coating the cavities of wacke; also in distinct crystals, disposed on radiated yellowish Arragonite; at Portstewart, very abundant (O'Hara's Rocks), lining the fissures and forming nodules in amygdaloid, frequently studded with pyramidal crystals of yellow carbonate of lime. Similarly at Magilligan, Benyevenagh, Aghanloo, Donald's Hill; white, near Slieve Gallion Carn, &c., &c. *Transparent*, at Down Hill, in small beautifully pronounced crystals, forming drusy coatings in the cavities of greenstone; these cavities are frequently lined with a thin layer of green earth, which gives the Analcime the appearance of being of a rich green colour. Where this coating is absent the mineral appears nearly black, or of a dark olive-green. Implanted tufts of radiating crystals of needle-stone frequently occur on it, and in the cavities small flat prismatic crystals of Arragonite. At the Castle Rocks, Magilligan, of a beautiful pearl-white, nearly transparent, with a very high vitreous lustre, in very minute drusy crystals, which to the naked eye have much the aspect of Hyalite; also at Carnowry, appearing of a rose-red, from the colour of the matrix. It is also found transparent. at Donald's Hill, Benbradagh (rarely), and Portstewart; at Doon Point, Rathlin Island, in large and very beautiful crystals studded with Mesolite, in cavities of greenstone, white and semi-translucent. It is an interesting fact, that the transparent varieties are invariably of a lower degree of hardness than the more opaque.

The only form of crystal, as yet observed in Ireland, is the Icositetrahedron.

SARCOLITE, (?)

Small masses have been found near the Causeway; but not in sufficient quantity to admit of a satisfactory identification.

LEHUNTITE.

The Lehuntite of Thomson is met not uncommonly at Glenarm and in many localities along the basaltic range. After a careful examination, however, of a very large suite of specimens, exhibiting every gradation, we cannot see any reason for considering this as a distinct species, but are compelled to view it only as a very slightly modified form of Natrolite.

HYDROLITE

Occurs in abundance at Island Magee, in beautifully marked crystals of the ordinary form; also with the prisms much elongated and the pyramids *not truncated.* The crystals are generally small, but sometimes large and imperfect; varies from nearly opaque to highly translucent, and in colour from a very light straw-yellow to a very deep flesh-red, or between rose-red and flesh-red. It is generally associated with Phillipsite, from which, however, it may readily be distinguished by its well-marked crystalline form, and by its colour, which is generally brighter than that of Phillipsite; or when nearly alike in colour, as is not unfrequently the case, the Hydrolite invariably presents a much higher degree of translucency and lustre. The *prismatic* planes are deeply striated transversely, the pyramidal planes smooth. At Larne Glen, and Black Cave near Larne, in large nearly transparent crystals of light flesh-red colour; at Deer Park, Glenarm, in large crystals, having but slight lustre of a white colour; at Down Hill in small crystals, rarely; at Craignashoke, in small white crystals of the ordinary form, associated with globules of Mesole, in the cavities of amygdaloid. Similarly at Benbradagh, and at Benyevenagh, Magilligan. In large, nearly opaque, greyish-white crystals, in amygdaloidal greenstone, at Portstewart, though not abundant.

For a careful analysis of the Glenarm Hydrolite, see Phil. Mag. August, 1840; and see also, Mr. Brooke, "On the Intersection of Crystals of Hydrolite and Chabasie," Phil. Mag. Vol. x., p. 278. April, 1837.

ERINITE (of Thomson),

Occurs in small nodules in a soft wacke at Ballintoy, accompanied by a green variety of the same mineral. It is also found in amygdaloid, at Island Magee, Larne, Causeway, and Dunluce.

STILBITE

Is not uncommon; at Ballintoy, abundant, generally of a rich pearly-white, sometimes of a creamy tint; also of a light oil-green, with a peculiar velvety appearance from the minuteness of the individuals; it occurs for the most part, disposed in sheaf-like aggregations on Heulandite, also itself investing the cavities; found also (rarely) in splendidly pronounced prismatic aggregated crystals, having a very slight divergence. Implanted dentiform crystals of carbonate of lime (yellow) frequently occur on it, and also thistle-form aggregations of fibrous Mesolite; it is sometimes also coated with Antrimolite; at the Causeway it occurs similarly to the Ballintoy varieties; at Portrush it occurs white, (? Spherostilbite,) in implanted globules with drusy surfaces (prehnitiform), also in aggregated prismatic crystals of rich lustre investing the cavities of the greenstone. These crystals have occasionally a somewhat cruciform character. At Benyevenagh, Magilligan, it occurs in stalactitical coatings to large crystals of carbonate of lime, its surface dull and nearly opaque, but having a rich lustre on the fresh fracture; often considerably decomposed externally, associated with Scolezite. At Aghanloo, similarly, and also in implanted globules, having externally a red tint, on Chabasie, in the cavities of amygdaloid.

At Donald's Hill, it occurs (rarely) snowy white, in drusy crystals lining the cavities of yellowish jaspery flints near the upper portion of the chalk rocks. We are indebted to Dr. Moore, of Dungiven, who zealously devotes his leisure moments to the examination of that interesting neighbourhood, for specimens of this very curious variety. In a remarkable trap dike, in the parish of Drumkeeran, County of Fermanagh, Stilbite occurs in sheaf-shaped aggregations, externally crusted with per-oxide of iron; internally of a light yellowish-green, with but slight lustre, associated with magnetic pyrites and hornblende. Of a similar character it occurs at Ramoan, Antrim, in small fan-like aggregations; and at the Conical Hills, Ballycastle. At Bruce's Castle, Rathlin Island, Stilbite occurs in very minute drusy coatings in the cavities of vesicular greenstone; the cavities are lined with green earth, which gives the Stilbite a green colour. Similarly at Dunluce.

HEULANDITE,

Though generally associated with the foregoing species, is by no means so common. At Portrush it is found in well-marked crystals in the small cavities of the greenstone, very rare; at the Causeway, both in minute aggregated crystals of dark colour lining the cavities of vesicular trap, and in large and well-pronounced distinct crystals; at Ballintoy, invariably associated with Stilbite, forming the coating next the matrix, with the Stilbites implanted; at May Island precisely similar. The colour in all these localities is a bluish-white, and lustre high. In small crystals, of olive brown colour and high pearly metallic lustre, in the porphyry of Sandy Braes.

PHILLIPSITE,

In greyish-white translucent crystals of some size, in a highly cellular amygdaloid at the Causeway. Similarly, but rarely at Portstewart; and at Magilligan; associated with Chabasie in all these localities. In small flesh-red crystals with Gmelinite, coating the cavities of reddish coloured earthy amygdaloid at Island Magee. The Phillipsite here always forms the coating next the matrix.

BREWSTERITE

Has been stated to occur, though rarely, at the Causeway, in small crystals of a slightly brownish-yellow tinge lining cavities in amygdaloid. We believe, however, that a variety of Heulandite, mentioned above, has been mistaken for it.

APOPHYLLITE

Is a rare mineral in this district. At Ballintoy it is found in a soft wacke, in four-sided pyramids, sometimes truncated, of a greenish or yellowish-white colour; translucent, or nearly transparent and white, associated with and disposed on Stilbite. Similarly and in a similar rock at Island Magee. At Portrush, in small beautifully transparent and perfect crystals of the primary form, implanted on Mesole, in the cavities of the Augitic rock; also in very large translucent crystals, whose solid angles are replaced by triangular planes, (the "Apophyllite epointé" of Hauy); sometimes presents a beautiful iridescence externally, arising from partial decomposition; also white and nearly opaque, associated with Stilbite and Laumonite. At Agnew's Hill, parish of Kilwaughter, County Antrim, in crystals precisely similar to those at Portrush. It is also found lamellar and massive in the Portrush rocks, and rarely at Fair Head associated with Mesole and Augite. A specimen from Ballintoy, procured in 1836, and which at the time was noted, as "highly transparent," is now white, nearly opaque and iridescent; this is in a private collection.

The Albin variety of Werner occurs, though rarely, at Portrush. The hardness of Apophyllite is given by Dr. Thomson, (Mineralogy, Vol. i., page 353, and in the Appendix, page 725,) as 6·25. It very rarely amounts to 5·0 none of the Ordnance specimens exceed 4·75.

RHODALITE

Occurs associated with Chabasie and carbonate of lime in the cavities of Amygdaloid at Ballintoy; similarly at the Causeway; Magilligan; and in minute quantities at several points along the range. The evident impurity of the specimens analyzed by Dr. Thomson, who formed this species, will always render it difficult to identify his mineral. The Ordnance collection, however, contains a specimen of a mineral, which in all probability will form the type of the species. Its description is as follows: *Colour*—Peach-blossom red, with small spots of a deeper tint; streak, same colour, rather lighter. *Hardness*—Yields easily to the nail; feels soapy, and acquires a polish by rubbing. *Texture*—Fine earthy, easily broken, cracks on exposure to the air; slightly translucent on the edges. Before the blow-pipe, *per se*, becomes white, intumesces slightly, and fuses readily with ebullition of a few air bubbles, and a very slight decrepitation, into a white vesicular globule; phosphoresces slightly during fusion, with a greenish light. With borax, fuses slowly with effervescence, giving a transparent glass, slightly tinged when hot, colourless when cold. With carbonate of soda behaves similarly to Dr. Thomson's; with nitre, indicates manganese.

The presence of the manganese seems to identify the two minerals, while the great purity of the Ordnance specimen, at once points it out as the type of the species. The results obtained with the blow-pipe, indicate a smaller amount of iron than Dr. Thomson's analysis. Through the kindness of Dr. A. Smith, we had an opportunity of examining a portion of Rhodalite, procured from Dr. Thomson himself, and were surprised to find that it fused readily *per se*, while Dr. Thomson states that it is "not altered." Dr. Smith also examined the specimens of this mineral, and his views correspond to those here stated.

MESOLE,

At Portrush, in mammillated, botryoidal, and reniform coatings investing the geodes of the greenstone; the surface is dull, drusy, and glimmering; internally they are radiating in structure, of a fine silky lustre, grey or greyish-white. The globules invariably have on the outer surface a thin concentric portion, differing in colour and generally of a higher and more pearly lustre; this appears to be due to a slight decomposition, not being observed where the globules meeting, have protected each other. At Magilligan, Carnowry, it is found investing the cavities of amygdaloidal wacke. At Slieve Gallion Carn in large globules associated with white Hydrolite. At Agnew's Hill, and Black Cave, near Larne, precisely similar to the Portrush variety; also in distinct globules implanted on the drusy crystals of Chabasie in cavities of greenstone. At N.W. of Rathlin Island, in distinct globules and in mammillary coatings associated with transparent Analcime; from the globules in many cases shoot filiform crystals of Mesolite.

IRON PYRITES,

Is very common in small disseminated crystals in all the primitive limestone, in larger crystals and masses in veins in the same rock; in nodules in the carboniferous shales of Tyrone and Derry. On the side of Slieve Gallion, parish of Lissan, it occurs in numerous small cubic crystals in a soft talcose rock; which, from the great number of the crystals, is very friable and easily decomposed. In numerous distinct crystals and nodules of aggregated crystals, in the tertiary clays, parish of Clonoe. Very large and perfect crystals (cubes) have been procured in hornblendic slate, at Prehen and Hollywell Hill, near Derry; and similarly at Tullybrick, Ballynascreen.

MAGNETIC PYRITES

Occurs in considerable quantity in a greenstone dike, parish of Drumkeeran, County of Fermanagh.

OXYDULATED IRON (of Phillips), OCTAHEDRAL IRON ORE,

In small but perfect octahedrons, of fine black colour; on exposure becoming coated with per-oxide of iron; frequently with a tempered-steel tarnish; also in rhombic dodecahedrons and in all the intermediate modifications, on the surface of amygdaloid at Island Muck, County Antrim, often coated with minute crystals of Analcime.

MICACEOUS IRON ORE,

In small six-sided tables, modified, having a brilliant tempered-steel tarnish disseminated on the fissures of greenstone, associated with prehnitiform Stilbite, at Benyevenagh. At Island Magee, in crystals and tables disseminated through and forming irregular strings or veins in clay-stone. At the Carrick Rocks, County Derry, and at Tullybrick, Ballynascreen, disposed on iron flint and quartz; in the latter case, in veins in the mica-slate, associated with iron jasper, and slightly titaniferous.

RED HÆMATITE.

Compact, fibrous, and botryoidal, in bole, at Ballintoy; similarly at Rathlin Island, and Tor Point, County Antrim; rarely at Benedy Glen, County Derry.

BROWN HÆMATITE

Rarely, accompanying the preceding. Earthy Hæmatite is found at Bardahessiagh, near Pomeroy, County Tyrone. Bog iron occurs in several places, back of Benbradagh; Muff, Templemoyle; near Cookstown; Rathlin Island, &c., but in no great quantity; under the trap rocks, near Craignashoke, earthy Brown Hæmatite, both compact and decomposed, occurs, associated with impure Lievrite (Amorphous). Similarly at Donald's Hill. *Ochre* is not uncommon in many places: occurs in abundance but impure, in decomposed rocks, parish of Upper Cumber; at Tamnadoey, parish of Desertlyn, &c., &c.

LIEVRITE,

An impure variety of amorphous Lievrite, occurs under the trap rocks, at Donald's Hill, and similarly at Craignashoke, parish of Ballynascreen.

CARBONATE OF IRON,

Crystallized in small rhombs, associated with prismatic crystals of carbonate of lime, near Stewartstown (Hazelton's Quarry); with pearl spar, in the limestone at Desertmartin; lamellar and of reddish colour in the cavities of the nodules of clay-ironstone, which occur in the shales of Ballynascreen; of a deep brown colour, with small implanted rhombs of white carbonate of lime, in limestone nodules, in the variegated marls of Dungiven and Bovevagh, and in several other places. *Clay-ironstone*, of light grey colour, occurs interstratified with the carboniferous shales in the Tyrone Coal Districts, and in nodules in the shales of Ballynascreen, Dungiven, &c., &c.

THE SPHÆROSIDERITE variety is found in small reniform mammillated masses, having a glimmering splendent lustre, in amygdaloidal greenstone, both at the centre and east end of Rathlin Island; very rare.

PHOSPHATE OF IRON,

Earthy, accompanies Bog Iron in very small quantities.

COPPER PYRITES

Is occasionally met with in small disseminated grains, in the primitive limestones of Derry.

GALENA

Occurs similarly, imbedded in the concretionary veins of crystallized carbonate of lime; Carn, Dungiven; Upper Cumber, &c., &c.

SILICATE OF IRON (ANHYDROUS),

Dark brownish-grey, with glimmering metallic lustre, occurs associated with Iron-flint, at Tullybrick, Ballynascreen; base of Slieve Gallion, parish of Desertlyn; and massive, at Lyle's Hill, County Antrim.

MINERAL CHARCOAL

Is frequently found in thin layers and pieces, in the Coal Field of Tyrone; at Benburb, &c., &c.

COAL.

The Tyrone Coal Fields contain Bituminous Coal, of an open burning kind, which cakes a little; and Cannel Coal, accompanied occasionally by Jet. In the Ballycastle Coal Field similar varieties occur. Adjoining the trap dikes which traverse this Coal Field, the Coal has lost its bitumen, and is converted into a close-grained porous cinder.

LIGNITE.

A thick bed occurs under the trap rocks, at Craignashoke, parish of Ballynascreen (see page 112); traces of it have also been observed in the trap, on the banks of Ballinderry river, a little below Coagh. It also occurs associated with the tertiary clays of Clonoe, Washing Bay, &c., County of Tyrone; at the N.E. end of Rathlin Island, it occurs between two seams of indurated clay in the trap rocks; above the Causeway of considerable thickness between two beds of columnar basalt, and is there much altered.

AMBER

Occurs in small lumps, in the cavities of the Lignite near Craignashoke, of a rich yellow colour and highly transparent. Sir C. Giesecké states that it occurs in the Coal of Rathlin, similarly.

THE CHLOROPHÆITE

Of Dr. MacCulloch is a common mineral in the Irish trap, occurring in small nodules in many of the layers and throughout the whole range. In some instances, it presents an ill defined reticulation on the surface, probably from imperfect crystallization. In small botryoidal groups in vesicular greenstone, at Down Hill.

CHAPTER IX.

SILURIAN STRATA—DESCRIPTIVE LIST OF FOSSILS.

A few years only have elapsed since the more ancient fossiliferous strata have been freed, by the labours of Professor Sedgewick and Mr. Murchison, from the obscurity which had enveloped them, when known only by the undefined names of Greywacke and Transition Strata; and they have emerged from that obscurity with all the freshness of a new creation. Under whatever light these strata may be viewed, they possess an interest peculiarly their own; they had long been considered as on the very line of demarcation between the period characterized as anterior to organic creation, and that in which the presence of fossil relics testified to the former existence of organic bodies, but now they exhibit a Fauna as rich and varied as that of almost any succeeding epoch, carrying us back to the remotest periods, and proving that the same power and intelligence were exercised and the same wisdom manifested in the earliest as in the latest acts of creation. The limited district now to be described shares in the interest of more extensive deposits of the same age; and it has an additional claim on attention in the extreme richness of its Fauna, as compared with the small topographical space it occupies. That Fauna is further remarkable in supplying species as yet undiscovered in England, and thus serving as a link of connexion between the Silurian deposits of Great Britain and those of the Continents of Europe and America; and looking at it in this light, it is impossible to avoid noticing a similar analogy in the existing Fauna and Flora of Ireland, which already include many continental species hitherto unnoticed in Great Britain. The coarse schists which occupy the principal portion of this small district, in the parishes of Pomeroy and Desertcreat, are extensively used as flags for building, and must, therefore, have come under the eye of many observers; but, doubtless from the supposed barren character of such strata, they seem to have excited little or no attention, and accordingly were not separated in Mr. Griffith's first Map, from the old red sandstone. The discovery by our collectors of the rich mine of fossils they contain, has, however, now placed them in their true position; and though other Silurian districts in the south and west have since been either discovered or more fully identified, the Pomeroy and Desertcreat district still stands pre-eminent amongst them. The position of these strata is remarkable (Pl. G, fig. 2): they rest at their base on granitiform and hornblendic rocks, which rise up behind them either in rough round knolls, like Bardahessiagh, or in sharper hills like Craigs, according to their composition. These rocks are extremely varied and beautiful, and will be described in detail in Chapter XI.; they are peculiarly interesting from the manner in which those of a syenitic or granitiform character are connected with others of a greenstone type, and from the many glimpses they afford, in their varied composition, of metamorphic action. Taking this latter circumstance into consideration, it cannot be said that the actual base of the once stratified rocks has been here arrived at, although it is remarkable that the schists now remaining, excepting in their induration, do not exhibit any peculiar marks of igneous modification, whilst the overlying sandstone in the development of porphyries within its range, affords numerous and striking proofs of metamorphic action. The tract in Tyrone, which can with certainty be considered Silurian, is extremely small, occupying a nearly triangular space, in the parishes of Pomeroy and Desertcreat, the base of which, running in the line of strike from E. by S. to W. by N., along the syenitic range, is about three miles long; and the perpendicular in the line of dip, southward, is also about three miles; hence, as the dip, where observable, is upwards of 30°, the total thickness of the strata, if considered continuous, would be at least 7920 feet; but such is probably not their condition, the strata having evidently suffered much local disturbance, appearing at one point to stand nearly upon their edges. The mass which exhibits the greatest appearance of continuity is that immediately south of the syenitic hill of Bardahessiagh; it extends in the line of dip about half a mile, and if estimated by the amount of dip, would therefore be 1320 feet thick. The two other topographical spaces in which the strata are exposed, are each less in extent, hence the thickness of the whole, supposing such a system of calculation correct, would be about 3500 feet. One remarkable peculiarity in this deposit is its abrupt termination eastward, where, in the line of strike, it is replaced by sandstones geologically of later date, by which it is also bounded in all other directions. This sudden termination of the Silurian schists, which renders their position isolated amidst the grits, the broken and detached character of some of the masses, and the great amount of dip, all indicate that they have been raised up from their original position, and subsequently undergone considerable wear and degradation. Another remarkable peculiarity is the absence of any well marked calcareous beds, although on the Tirnaskea or small river there are thin calcareous layers of three or four inches thick mixed with quartzose bands, no fossils, however, occurring in them, but pyrites in abundance. Occasionally also a thin layer of grit is observed associated with the schists, and near the junction with the overlying sandstone the schists themselves become very gritty, and pass into sandstones. This absence of those well marked calcareous strata which characterize the Silurian system of England, has doubtless influenced the distribution of organic bodies, and renders it difficult to fix upon subdivisions; still, however, there are some zoological differences in the successive beds, and those not without interest. At the very base of the system adjacent to the syenitic range the schists, which are coarse, and on their surfaces exhibit those markings, like the stems of algæ, and the tortuous labyrinths of annelides, &c., so common to indurated muddy or sandy strata, abound in the large Orthides, which appear to represent Mr. Murchison's Orthis grandis, and are evidently in the position of the Caradoc sandstone; it is therefore remarkable that this should be the locality of Paradoxides bi-mucronatus, (Murchison,) a fossil of the Wenlock limestone, and of the genus Harpes, two species of which occur in great abundance, although the genus had hitherto been confined to the Eifel, or Devonian system. The genera Illænus and Isotelus are not rare; Trinucleus, Phacops, &c., also occur; and the only specimens of the large Nuttainia, Pl. iv., were found here. This was also the habitat of Avicula orbicularis and A. obliqua; of the Inocerami, figured Pl. xxxiii. figs. 1, 2, 3; of the remarkable Isocardium, (?) fig. 9; of the Avicula, fig. 6; of Mytilus Nerei, fig. 10; and of various Orbiculæ, Pl. xxxii., &c.; it has, therefore, a tolerably distinct zoological character, though plicated Terebratulæ, of species common to the upper divisions, such as Terebratula lacunosa, &c., descend into and are abundant in it.

Though not actually seen in the line of section, this is about the parallel of the fine black schist which abounds in graptolites, three, if not four species, of which the most remarkable and abundant is Graptolithus Sedgewickii, (Portlock,) having been discovered in one locality in the bed of the little stream in Lime Hill townland, Desertcreat parish. This peculiar schist, which also contains small plicated Terebratulæ, Pl. xxv. figs. 2, 3; Posidonia venusta, Pl. xxv. fig. 4; a small body which probably belongs to the doubtful tentaculites; and also, though very rarely, a Mytilus, common to it and to another graptolitic bed in Fermanagh, has certainly a very marked zoological character; the graptolites, which almost cover the surface of a favorable layer (see Pl. xix., fig. 2) being replaced in the higher beds by foliaceous, or double graptolites. Still ascending, the schists retain generally a gritty or sandy character, though they are often much smoother, and sometimes slightly calcareous. This portion of the principal or lower mass, where the Tirnaskea river has cut through the strata near Dickson's House, or near what is usually called the Slate Quarry, was the favorite habitat of the crustacean genera Remopleurides, Trinucleus, Ampyx, Phacops, Isotelus, Illænus, and of many highly characteristic molluscs, most of which would, without hesitation, be classed with the fossils of the Caradoc sandstone; but then again they are associated with the genus Calymene, which belongs to a higher division, and with a new species of the genus Brontes, and thus here also, as in the still lower beds, there is a mixture of fossils of various parts of the system, from the Caradoc sandstone up to the Lower Ludlow. The more gritty beds, which are still higher in the system, and ultimately pass into what may be called a schistose sandstone, gradually become less rich in fossils, although at the point, which may be considered the very last visible step of the formation as here exhibited, Leptæna sericea still holds its place, being associated with other brachiopoda of a more doubtful geological character. Such, then, is this small, but remarkable Silurian district, rough and wild in its external features; undivided by alternations of different kinds of mineral deposits into distinct divisions; preserving with this similarity of lithological character a corresponding similarity of organic type, though with a sufficient mixture of other fossils to show that, as a deposit, it has extended beyond the limits of the Caradoc sandstone, to which, in mineral and fossil character, it is most nearly assimilated. Here, therefore, would end the preliminary stratigraphical notice of this formation, had not the researches of the last season brought to light another portion of the Silurian schists at Lisbellaw, in the County of Fermanagh, where they are protruded through, and form an anticlinal line amidst the strata of the overlying sandstone, with the lower conglomeritic beds of which they are distinctly alternated. These are also sandy schists, approximating in mineral character to the graptolitic schists of Desertcreat, though not so dark or smooth in appearance, and like them being characterized by a profusion of graptolites, some of the species of which are not specifically the same in the two localities; Graptolithus sagittarius here replacing G. Sedgewickii, and foliaceous graptolites, as G. pristis, being also abundant. The principal associated mollusc is a Mytilus (Pl. xxv. fig. 5, 6), the young form of which, fig. 5, is also met with, though rarely, in the Desertcreat schists, and here, as in them, black shining carbonaceous (?) expansions are common on the surface, together with the usual markings, like annelides and algæ. The striking difference of the graptolites in these schists, and the distinct alternation of the schists with conglomeritic beds, which are evidently part of the overlying sandstone system, mark the deposit as a more recent stage of the Silurian system than that of Tyrone. The alternating conglomerates are also deserving of notice, as they contain a great quantity of primary, or igneous pebbles, some of which so closely resemble the rocks of Slieve Gallion that they may be assumed to have come from that quarter; but if so, the result is very curious, as in that case the altered rocks of a hornblendic type must have undergone their change prior to the commencement of the old red sandstone era, whilst another portion of altered rock is connected with, or posterior to, that formation, implying the repetition or continuance of igneous action for a considerable period within the same limited district. The dip of the schists, at the town of Lisbellaw, where they are so distinctly associated with the conglomerates, is about S. 60° E., and in amount considerable, or about 40°; but on proceeding more to the interior of the deposit, they are seen nearly vertical, and at length dip over to the N.W. at a very high angle. It cannot be doubted, therefore, that they form here an anticlinal axis, as shown in Pl. G. fig. 7, and all along the escarpment of the overlying sandstone occasional examples are observed of its strata, exhibiting a similarly double, or reversed, dip, as if connected with a general, though not strongly marked axis.

To understand more fully the geological importance of these seemingly insignificant deposits, it is necessary to study their fossils, and compare them, first, with those of succeeding formations; and secondly, with those of other countries; and in doing this, several very striking results will become apparent. The combination in the ancient Fauna of this district of the species of different countries has already been noticed; but the strongly marked line of demarcation exhibited in some of its organic families between that Fauna and those of succeeding periods is perhaps even more striking; in fact, there is here no such intermediate formation, in a fossil sense, as the Devonian system—that is, there is no formation in which fossils peculiar to itself are commingled with a large per centage of those belonging to the Silurian on the one hand, and to the Carboniferous on the other. This is most strikingly shown by the Crustacea, the Trilobites of the Silurian schists being specifically, and it is probable, (as will be hereafter shown) generically distinct from those of the carboniferous limestones; but although this is the case, no strata occur between them, in which the Trilobites of both are mingled together. Of Zoophyta there are few in the schists, but so far as they go, with one exception they support the same view, and the only species of the Echinodermata, as yet discovered, is apparently new and peculiar to the Silurian strata. In the Mollusca, also, though perhaps some very few species may appear to have a range extending, as has been observed also in England, beyond the limits of the formation, there is certainly no intermediate system visible here in which characteristic Silurian and Carboniferous mollusca meet together. It is difficult to assign a satisfactory reason for this absence of fossiliferous transition strata at the base of the Devonian system, more especially as the Silurian schists of Fermanagh are so distinctly in contact, and associated with the overlying sandstones, that a transition, or mixed system, if such had anywhere here existed, should have been detected at that point; but though graptolites, on the one hand, are so abundant, and some of the other fossils, particularly the Trilobites, which are rare, are rather obscure, there is no sufficient evidence on which it could be safely established; is it not then probable that whilst the schists belong to the lower section of the Silurian system, some portion of the overlying, and even conformably associated, sandstones are actually members of the upper sections of that system? But to place the subject in a clear light, it is necessary to go through the fossil evidence; and for this purpose the class Crustacea will be first selected, as exhibiting the most strongly marked differences in the successive periods.

Crustacea.—Before entering upon the consideration of this class of the animal kingdom, the more important in its connexion with this portion of the stratified crust of the earth as it is there exhibited in forms at once peculiar and characteristic, it seems desirable to give a brief abstract of the various opinions which have been published on the nature, analogies, and affinities, of those fossil crustacea which constitute the remarkable family of Trilobites, or Palæades of Dalman. And in doing so it may be well to premise, that however linked together the several genera and species included in that family may appear to be, by the common want, in the present state of knowledge respecting them, of either feet or antennæ, which are organs of such importance in the study and classification of recent crustacea, it can scarcely be doubted, that had they been seen in their living state, such marked variations in their external form would have been attended by peculiarities both in adjunct organs, and in internal structure, sufficient to have authorised, not merely a further generic subdivision, but also the formation of more families than one; and even now, amidst the uncertainty consequent on such deficiencies, it may be fairly asserted, that as some of the numerous forms exhibited by these fossils approximate to one type, and some to another, they cannot all be brought into connexion with any one living type. Few, indeed, of fossil bodies have given rise to such various and widely differing opinions; some of the earlier writers having even described them as fishes. Lhwyd, for example, referred one of the wide and flattened Asaphs, to the genus Buglossus or common sole, considering the fossil as the skeleton of the fish, and quoting Aldrovandus as having described similar fossils as icthyomorphous bodies. Thus far, therefore, no advance had been made towards a proper understanding of these fossils, and it is even worthy of remark, that Lhwyd did not see the affinity between the Asaphs, thus assumed to be the skeletons of fishes, and those other fossils of the same class, to which, whilst candidly admitting his ignorance of their true place in the animal kingdom, he gave the name, Trinucleum fimbriatum vulgare; given, as he says, provisionally, that they might not remain without name, until their true genus should have become more apparent.

The views of subsequent writers up to the time of Wahlenberg, cannot be better expressed than in the words of that author, who substituted for the Linnæan name Entomolithus that of Entomostracites: "Of almost all petrifactions, (he says) this is the most obscure, and recedes the most from living objects; so abnormal even is it, that after its true affinity had been indicated, some writers still remained dubious, and again wandered from the truth. The most ancient authors bestowed upon it the name of 'three-lobed shell,' which suiting well the portion most commonly called caudal, gave rise to the ordinary designation Trilobite. Linnæus, with his accustomed penetration, considered this fossil to approximate nearest to his Monoculi; and shortly afterwards, when the whole articulated body had become more common, there were not wanting others who rather believed it to be an Oniscus; whilst again, in later times, the articulations of the body being considered as imbricated valves, it was supposed to be a Chiton. How much more probable the former opinion (that it was an insect,) is, may be judged from its possessing compound reticulated eyes; but as those eyes were immovable, it cannot, although aquatic and crustaceous, be considered a true crab. With the Onisci it agrees in having a long articulated body, but is entirely different as to the construction of the head and thorax; in the Onisci, the head is notched in front for the insertion of the antennæ, and behind is thrust into the first segment of the thorax, the angles of which projecting forwards almost embrace the head, though not in such a manner as to impede motion, whilst in these tri-lobed fossils the anterior rim of the head-plate is not, as it were, rounded inwards and so formed into a closed curve, but is so produced outwards and backwards as to include within itself, in the manner of the segment of a circle, the whole portion of the thorax intended for the insertion of feet; and indeed is so perfectly connected with it, that no suture remains to assist in distinguishing the head from the thorax, and much less is there any motion between them. As, therefore, so different a conformation of most essential parts, must be considered of greater weight in deciding natural affinity, than the correspondence in the articulations of the body; and as the same mode of structure occurs in Monoculus polyphemus, it appears to me no longer doubtful, that the affinities of these fossils are much closer with the Monoculus polyphemus than with the Onisci, although articulations are present in the Onisci and wanting in the Monoculi; an opinion which has been strikingly confirmed by a most careful comparison of the affinities and functions of the so called Entomolithi and Monoculi." Wahlenberg then describes the position of the mouth in the Monoculus polyphemus, as central, and surrounded by feet, which are directed inwards, and are fitted for manducation rather than for locomotion, the head and thorax being consolidated together so as to afford a firm basis of attachment to such organs. He also notices transverse elevations on the upper surface of the head-plate, exactly corresponding to the insertions of the feet in the lower; and considers the whole organization of the M. polyphemus, as so directed towards the one object of "devouring," that above all other animals it may be called centrivorous: and then adds, that as far as could be expected, traces of the same structure may be found in the fossils, namely, the same solidity of the head-plate, the same transverse protuberances indicating the insertion of similar feet, and so on. And further, as the M. polyphemus is the only insect which in magnitude approaches to our fossils, and has also been found fossil, we may assume that it is now, amongst living Crustacea, the last remaining member of the voracious family which was formerly represented by the Trilobites; the more recent species of Trilobites being those which approach the nearest to the Monoculus polyphemus in their whole structure, differing only in the addition of articulations, and those few, of the body; whilst the more ancient recede from it, in the increased number of the articulations, in the want of eyes, in the greater size of the head, and in the greater elongation of its marginal horns; (reasoning which is embarrassed by too many exceptions to be conclusive.) Since therefore, the affinity of these fossils with the Monoculus polyphemus (Limulus gigas, Muller) has been thus indicated, it is right to examine and compare their respective organs; as, for instance, the Limulus possesses (concealed under its caudal valve) laminæ rather respiratory than natatory. And it may be therefore asked. whether similar organs can be found in all Entomostracitæ attached to the articulations of the body? And such, indeed, " was my opinion, as the caudal valve in some species was entirely too small to have given attachment to the whole respiratory apparatus. It is also probable that, as in the Limulus gigas, these organs were so much under the back or middle portion of the body, as to have left the sides of the trunk entirely vacant; and also in like mannner, the feet or rather the maxillary claws, were concealed under the middle portion of the anterior shield. Considering, then, how small all these parts must necessarily have been, it is readily understood why no vestiges of them have been discovered in the fossils, more especially as it is highly probable, from the great difference in the size of different individuals of the more perfect species, that in the course of growth, after the manner of crabs, they had cast their crusts; so that the large plates and body of rings usually found, are to be considered cast exuvia, and the convoluted specimens to be regarded as the only remains of individuals who have died in a perfect state" (Nova. Acta Reg. Soc. Sci. Upsal, vol. viii.)

The reasoning of Brongniart in his excellent systematic work, is nearly the same. Yet, whilst referring to the Limulus polyphemus and Apus cancriformis, as exhibiting the antennæ reduced to mere rudiments, or as altogether deficient: and the feet, by the change of their functions, diminished in strength and concealed under the buckler, or head-plate, he attaches more weight than Wahlenberg to the transverse articulations of the body, and sums up the whole thus:—"The general form of the body of Trilobites, its constant division into a head confounded with the corselet, an abdomen, and a post abdomen; the sessile eyes, the rugosities and tubercles of the skin, and the habit of rolling itself up into a ball, so striking in the Calymene; form together a combination of characters which corresponds only to the crustacea of the order Gymnobranchia; such as Ligia, Spheroma, Cymothoa, &c."

The great difficulty which appears to have impeded the determination of the natural affinities of these remarkable fossils, has arisen from the too general character of the terms of comparison, looking either at the recent types on the one side, or at the very varied and widely differing forms of the fossils on the other; for it is evident that whilst the Limulus affords a fitting type of comparison for some of the fossil species, it recedes so widely from the forms of others, as to render a comparison highly embarrassing. And in like manner, a general comparison with the Cymothoidæ, &c., is beset with equal difficulties, augmented as they are by the imperfect subdivision of the genera, which even yet include under the same generic denomination very dissimilar forms. The highly interesting discovery by Stokes and Dekay, of part of the lower surface of a Trilobite, exhibiting an organ which in its probable functions appears to resemble part of the maxillary apparatus of the Apus cancriformis, at length dispelled some of the obscurity and vagueness of former comparisons, by bringing them more within the limits of individuality. To the Trilobites possessing this remarkable organ Dekay gave the name of Isotelus, separating them from the Asaphs; and it may be assumed that if a group were formed of that genus and others in general characters approximating to it, such as Illænus, Nileus, Bumastus, &c., it would constitute the true connecting link in the chain of organization between these obscure fossil crustacea and the recent genera Limulus and Apus. The external difference between them is slight, as in both there is the same great extension of the buckler, the same separation of it into head and caudal plates, and the same habit, as remarked by Green, of closing inwards the caudal over the head-plate, in which condition the resemblance would indeed be most striking. And, as to the existence of articulations between the two divisions of the buckler in the one, and their absence in the other, it amounts to no more than the removal of a portion of the buckler and its replacement by articulations sufficient to give greater flexibility to the animal.

Dalman, after discussing the opinions of preceding writers, came to nearly the same conclusion as Wahlenberg, seeing a connexion of affinity between the Trilobites, or Palæades as he designated them, and the genera Limulus, Apus, and Branchipus, and one of analogy only between them and the genera Sphæroma, Cymothoa and Idotea, or, generally, of affinity between the Palæades and Monoculi, of analogy between the Palæades and Onisci.

The scope and object of the well-known and admired work of Dr. Buckland, naturally led to a close inquiry into the natural affinities of these remarkable fossils, and to a careful representation, as the basis of comparison, of the supposed living types. Those selected were the genera Branchipus, Limulus, and Serolis; but whilst Dr. Buckland allows due weight to the evidence afforded by the organ discovered by Stokes and Dekay, he appears to depend more on the similarity of external structure exhibited between Trilobites and articulated crustacea, and hence brings most prominently forward the genus Serolis, individualising, in his interesting discussion of the points of resemblance, the comparison, by making it not a general one, but definite, as between that genus and the old genus Asaphus. The position, form, and structure of the eyes, the tri-lobed character of the articulations, and the general aspect of Serolis, are indeed in most striking accordance with those of Asaphus, provided that genus be limited to those species only which resemble in general characters, and constitute a group with, Asaphus caudatus; but they would harmonise very indifferently with those species, which are now so properly separated under other designations, as Isotelus, &c. The effect of Dr. Buckland's reasonings has been to strengthen the evidence in favor of an affinity between the Cymothoidæ and one portion of the present family of Trilobites, whilst it leaves unshaken that for connecting another portion with the genera Apus and Limulus.

Milne Edwards adopts nearly the same reasoning, and places the Trilobites as an intermediate link between the Branchiopoda and the Isopoda. His memoir forming part of the 2nd Edition of Lamarck's "Animaux sans Vertebres," is enriched by a very copious list of species, and authorities. Bronn in like manner looks to the genera Idotea, Ligia, &c., as analogous in point of external structure, and to Apus, &c., for illustrations of the supposed maxillary apparatus; and this view of the intermediate position of Trilobites between two distinct groups, the Branchiopoda and Isopoda of Lamarck, or the Xyphosura and Isopoda of Edwards, or the Entomostraca (Branchiopoda,) and Amphipoda of Latreille, is strongly enforced in "Observations on Trilobites, founded on a comparison of their Structure and that of living crustacea, by W. S. MacLeay, M.A., F.L.S., &c.,"

forming part of the great work on the Silurian System, by Mr. Murchison.

In weighing the arguments brought forward by various writers in favor of their respective views of the affinities of Trilobites, Mr. MacLeay points out the difficulties which embarrass every attempt to connect them with recent crustacea at any one point. He considers the non-discovery of antennæ, or of any certain vestiges of feet, (Eichwald's supposed discovery not being satisfactorily established,) as incompatible with their former existence; since it is scarcely possible that the remains of a soft annelide should have been preserved, (he might have added, and the delicate spines of Trinucleus, Ampyx, &c.) and yet the antennæ and feet (however comparatively soft they may have been) of such crustacea have undergone total destruction. Hence he considers the supposed relation of Paradoxides with Serolis, on the ground of absence of antennæ and crustaceous feet, to be one merely of analogy; and in like manner, from the absence of feet, he negatives that between the Trilobites and Limulus. The opinion of Wahlenberg that the remains of Trilobites were principally cast crusts, is not alluded to by MacLeay; and in truth, although that opinion is probably in part correct, and sufficient to explain the want of connected antennæ, it does not, as a theory, explain satisfactorily the total absence of even fragments of detached antennæ or crustaceous feet. To avoid then as far as possible the great difficulties of the comparison, Mr. MacLeay approximates the Trilobites on the one side to the genus Apus, and on the other to the genus Bopyrus; but, considering that even under all the advantages of this selection, the Trilobites still differ in so many respects from both the Amphipoda and Entomostraca; he classes them in a distinct order, "intermediate between the tribe Isopoda on the one side, and the tribe Aspidophora on the other," an arrangement virtually the same as that which had been previously proposed by Milne Edwards.

To these essays on the comparative affinities of Trilobites may be added one by James Eights, naturalist to the American exploring expedition of 1830, as communicated by him to the Albany Institute in 1833, and published in its Transactions of that year. Mr. Eights discovered on the shores of South Shetland, a very remarkable crustacean resembling in general form

Serolis, but differing from it in a much greater elongation of the sides of its plates, by which arrangement it acquires a still more decided character of trilobation. He compares this crustacean with Paradoxides, and points out many striking features of resemblance, such as the general form of the body and articulations, the form of the head, and the position of the eyes which, in his opinion, corresponds with certain marks on the head of the Paradoxides which may also have been the places of eyes. Mr. Eights constitutes of this crustacean a new genus, taking for its name that of Professor Eaton's doubtful fossil genus, Brongniartia, and for its specific designation, trilobitoides. It possesses, however, very strong antennæ, and hence, as in all the other cases, is strongly distinguished from true Trilobites.

Having thus sketched the progress and present state of opinion on the affinities of Trilobites, the peculiarities and probable functional objects of their structure, as bearing on their classification, will next be noticed. It has been proposed to distinguish Trilobites into such as possess, and such as do not possess eyes, a principle of division which seems insufficient, inasmuch as it cannot be stated positively that any of them were without eyes; although the eyes, in some, having been elevated above the plane of the head, were so prominent as to leave distinct impressions of their reticulated surface, whereas, in others not having been so raised, nor so strongly marked, such impressions are wanting. It is only necessary to examine the eyes of the Cymothoida, and to inquire what impression their surfaces would leave in the mud moulded round their decaying bodies, to perceive that such eyes, often appearing quite smooth and simple, although their complicated structure can be discovered on holding them in a favorable light, would have left no trace of their structure behind them. The apparent absence of eyes in some Trilobites is therefore an argument for their connexion with crustacea possessing eyes level with the surface of the head, rather than one for their separation from them; hence the affinity between Paradoxides and the Cymothoida may be really greater than that between the Cymothoida and Phacops, notwithstanding the presence of compound eyes in Phacops, and their absence in Paradoxides. The difficulty is, however, much more formidable in the case of the antennæ, as it is most probable that some fragments at least must have been preserved had they ever existed. So marked a difference, then, between Trilobites and the great body of living crustacea, seems to require more than their partial separation as a family ; to require, in fact, the establishment of a distinct order. Looking indeed at the remarkable fringe which borders the front of the buckler of the genus *Trinucleus*, its regularly disposed, bordered, and perforated surface, and again at the buckler of *Harpes*, there is something like an approximation to part of the external structure of the Echinida, and the Trilobites may have formed a link of connexion between them and the Crustacea.

Admitting the absence of antennæ to have been original, not accidental, it is remarkable that the backward prolongation of the head into lateral spines, which appears rudimentary in some of the Cymothoida, as, for example, in Æga and Cirolana, becomes in many of the Trilobites a marked and highly important peculiarity of their structure. In Paradoxides, Phacops, Ampyx, Trinucleus, this is so much the case, that it appears highly improbable that it could have been without some specific use. In Phacops, these prolongations are flat and broad ; in Trinucleus and Ampyx they run out into long spines ; and in these two genera, at least, it does not appear unlikely that they formed part of the locomotive apparatus of the animal. In Ampyx, for example, the caudal plate or post-abdomen, closes over part of the lower portion of the buckler, but is not received into any depression of the body, as is the case with the abdomen of the Decapoda brachyura ; hence, if the animal be considered in such a position as to rest on this doubled over tail or post-abdomen, having its long spines extending backwards on each side, a sudden opening of the tail would act as a spring and raise the whole body on the points of the spines as levers. Its progressive motion would thus be by hops ; and it might be considered on the muddy or sandy shores of seas of those ancient epochs, the representative of the Talitri, &c. This observation, however, only applies in its full force to those two genera, Trinucleus and Ampyx, and is an additional argument in favor of a careful avoidance of too general deductions, which only obscure the right perceptions of natural affinities.

The preceding remarks had reference principally to the classification of Trilobites, on the ground of differences in their general appearance, and their probable relation to more than one form of living crustacea. The details of their structure afford data for subdivision, the value of which it is desirable to estimate; and this cannot be better done than by an analysis of the investigations of Pander—(Beiträge zur Geognosie des Russischen Reiches, 1830). That author begins by noticing the difference in the number of articulations of the trunk, body, or thorax (abdomen, Brongniart), which number bears, in his opinion, a certain proportion to the degree of development or perfection of the other parts. Of known Trilobites he supposes Agnostus (Battus, Dalman), to be at the bottom of the scale, as the thoracic segments disappear, and the head and tail plates are thus brought close to each other, being connected by a simple articulation or fold; and Amphion at the top, in which there are 20 articulations; various other genera exhibiting intermediate numbers, such as Asaphus granulatus (Trinucleus) 6, Nileus and Asaphus (Isotelus) 8, Illænus 10, Calymene 12, Zethus 16, between which numbers others will probably be yet interpolated as the result of future research and discoveries. Proceeding to the conformation of the segments of the thorax, the simplest form is found in Nileus, where they form parallel transverse bands, lying one behind the other, which, in the middle, pass under and adhere to each other, being separated only by a straight fold, whilst towards the sides, at about the second quarter from the extremity, they are bent from the straight line towards the caudal division, and so separated from each other as to project outwards from each side of the simple axis, forming eight distinct sideward prolongations. To this knee-like bending, Pander applies the term *knee*; in Nileus Chiton, it is much rounded; in N. Armadillo, it is marked by a more decided bend; in Illænus, it is still more crooked; and in Amphion, it is very much rounded. In Asaphus (Hemicrypturus and Isotelus) and Calymene (Phacops), in which the knee does not exist, the body segments extend (when fully expanded) in a straight line from the centre to their extremities; and the knee, which in the preceding genera facilitated the rolling up of the body, and probably also contributed towards locomotion, is replaced by a fold in the crust, which is generally strongest and deepest where the knee should have been. This fold appears deeper or shallower, according as the Trilobites are found expanded or rolled up, thus intimating that their outer crust must have been, though in a small degree, flexible.

In Paradoxides, judging from the figures of Wahlenberg, Brongniart, and Dalman, the knee and fold occur together; that genus, therefore, differs from those already noticed in which the one or the other is found alone, and hence it may be conjectured that in the function of locomotion it was more fully provided for than other genera.

The body (thorax) exhibits another form of difference in the mode of its longitudinal subdivision into three parts, a central (stem, spine, or axis) and two side lobes. In Nileus there is no such division, the central or spinal portion extending simply and without interruption to the knee. In Asaphus (Isotelus) and Illænus, the division is produced by notches or crimpings on the middle portion of the body, (whence the name Trilobite,) which form furrows between the folds in the former, and in the latter between the knees, the depth of which, as in the folds of the side segments of Asaphus (Isotelus, &c.), seems to depend on the different states of petrefaction. In Calymene, Amphion, and Zethus, on the contrary, this division is more distinctly expressed and penetrates much deeper, the crust bending itself inwards and forming a remarkable fold. Such variations in the mode of division of the trunk into spinal and side lobes, produced in different genera a corresponding variation in the facility of moving the segments one upon the other, as they were moved more easily from their ordinary position in those provided with a longitudinal fold than in those which had only a notch, and in this respect therefore the latter were inferior to the former. The difference in the comparative breadth of the spinal and side segments is also noticed; in Illænus the spinal is as broad, or even broader, than the side segments; in many Asaphs the spinal portion is much smaller than the sides; and in Calymene, Amphion, &c., the sides are often even twice as broad as the spine; though caution is required in such comparisons to guard against the errors which may be occasioned by the various bendings and archings of the segments. In like manner as the line carried through the succession of notches or folds of the middle body, or spine, may be called the spinal line or lines, so Pander calls that which passes through the successive bends or knees of the side segments, the knee line or lines, and uses it also as a means of comparison; in Nileus it conforms to the outline of the animal, the lines on the opposite side approaching as they descend from the head; and this is also the case in Calymene, Amphion, Zethus, Paradoxides; on the contrary, in Illænus their course is quite different, as at the head end of the trunk the two lines are nearest, and in descending downwards recede, somewhat obliquely, from each other. In the formation of the head-plate, buckler, or that division which combines the head and part of the thorax of other animals, Pander discovers differences corresponding to those of the body; in Nileus, where there are no distinct spinal lines to separate the spinal from the side segments, the head exhibits an uninterrupted convex surface; in Illænus and Asaphus, where the separation is produced by notches, the spinal lines are prolonged into the buckler, in Illænus a short distance only, but in Asaphus to the extreme front. In Zethus, Calymene, Amphion, where the trilobation of the body is produced by a fold in the crust, this is also the case in the buckler, the central in some cases being divided from the side segments by a deep furrow, as in Calymene Blumenbachii and Amphion frontilobus; and in like manner also the lateral portions of the buckler exhibit, in some genera, marks of separation into parts corresponding to the side segments of the body. The position of the eyes, sometimes near to, and sometimes removed from, the central lobe, is also found to vary with other parts, being on the outside of the prolongation of the knee line in those genera where a true knee exists, and in those where a fold replaces it, between the spinal line and a line which may be supposed to represent the knee line, consequently nearer to the central lobe. The eye line, which by Dalman was considered one of the best means of distinguishing species, is conjectured by Pander not merely to mark an external subdivision of the buckler, but a line of positive separation between its several parts; the animal having had, according to him, the power of moving them, both up and down, though this is evidently no more than mere speculation; and, finally, in the caudal plate, the differences as regards the downward prolongation of the spinal segments correspond to those of the head. These remarks of Pander are of great value; and, when combined with his researches into the condition of the under crust of Trilobites, which in those he was enabled to examine, appeared to exhibit generic differences exactly in accordance with those of the upper crust, invest the consideration of Trilobites with somewhat of that certainty which can alone be attained by anatomical investigation. Several principles of practical application may also be deduced from them:

1st. That the central lobe of the buckler, with its transverse folds, furrows, or lines, is merely a prolongation upwards of the central or spinal thoracic lobe; and the central lobe of the pygidium is a similar prolongation downwards of the spinal lobe of the thorax; whence it is evident that the same, or nearly the same proportion between the centre and sides must exist in stem, buckler, and pygidium.

2nd. That the difference in the comparative breadths of the spinal and side lobes, in some nearly allied genera, is accompanied by a difference in the structure of the under crust, and hence is a true generic mark of difference.

3rd. That the form of the segments of the side lobes, (paddles, Zenker), is so various as to become an additional means of separating nearly allied genera.

4th. The mutual relation, in form and proportions, of the buckler, trunk, and pygidium, being definite, not arbitrary: disjoined fragments should not, without great caution, be considered parts of the same individual. Several imaginary wholes have already been the result of such combinations of heterogeneous parts, and, in like manner, distinct species have been brought together, as varieties of the same, from a neglect of the full comparison of all the parts. Thus, for example, Brongniart, in Pl. I., fig. 2, combines at least two species in one, his fig. 2 c being manifestly distinct from fig. 2 b, as both the buckler and the caudal extremity are totally different. And in Murchison's Silurian system, the head and tail of two widely different species, probably even belonging to different genera, are joined together as Asaphus Powisii, Pl. 23, fig. 9, whilst the species figured in Pl. 24 and in Pl. 25, fig. 1, are named varieties of Asaphus Tyrannus, although exhibiting marked differences of structure; and again in Ogygia Murchisonii, Pl. 25, fig. 3, a head resembling that of an Ogygia, is associated with a pygidium totally different in character from that of the genus as figured by Brongniart—examples sufficient to show the necessity of greater precision in the generic characters of Trilobites.

The probable use of the side segments as locomotive organs had been (as already stated) pointed out by Pander; but this idea is greatly enlarged upon by Zenker, (who does not appear to have seen Pander's work) in his "Beitrage Zur Naturgeschichte der Urwelt." According to his view of the matter, the segments of the lateral lobes are not integral parts of the body, but are true paddles or locomotive organs, the middle lobe alone constituting the true body; and hence that the whole family of Trilobites, instead of being approximated to still existing crustacea by the recognition of trilobation in both, should be considered an isolated group. The first difficulty in the way of this explanation is the breadth of the buckler and pygidium, which corresponds to that of the central and lateral lobes taken together, not to that of the central one alone. Zenker endeavours to remove this difficulty by considering the central division of the buckler as alone the true head, and in like manner the central division of the pygidium as the true abdomen, the side portions of each being respectively head and tail feet, or fins, anchylosed together, just as the lateral caudal appendages of the genera Astacus and Palinurus might be supposed united into one large caudal plate. But if this explanation removes one objection, it certainly leads to another of even greater weight; namely, that the eyes would no longer belong to the head. Zenker, indeed, remarks on their position, that "in a singular manner the eyes are never found on the true head;" the deduction, however, should rather be, that the true head extends over the spaces within which the eyes are fixed, that the central portion is the prolongation of the axal lobe of the thorax into the region of the head, constituting with it the cephalothorax, and that the marginal portions alone, extending, as they sometimes do, into horns or spines very analagous to similar prolongations of the costæ of Paradoxides, &c., represent in the buckler the side segments, or costæ, of the thorax. The opinion of Zenker appears to have been again advanced in "Weigman's Archives," by Quenstedt, Professor of Geology in the University of Tubingen, and to have been adopted from him by Von Buch, who in his remarks on Asaphus expansus, uses these words; "on each side they are provided with strong broad fins, one for each segment, the nature and object of which can here be scarcely mistaken; they are oars, which strike the water backward with their broad surfaces, and these, in being brought again forward, are turned so as to present to the water a thin edge, offering but little resistance."—(Beitrage Zur Bestimmung der Gebirgs formationen in Russland, 1841.) Notwithstanding, however, the weight of these authorities, this application of the side members as swimming organs in Asaphus (Hemicrypturus), Illænus, Isotelus, seems at least doubtful, as in those genera they are continuous with, and not articulated to, the central segments, and could, therefore, have been turned to and fro only by a species of torsion. Something like articulation does indeed appear in Calymene, in Phacops, and in Remopleurides, the form of the paddles of the latter still further strengthening the supposition that they may have been used as swimming organs; whilst, on the other hand, the form of the side members of Trinucleus and Ampyx seems quite unfitted for such an object. It is most probable, therefore, that whilst the side members, or costæ, occupy the place, and are the true analogues of the lateral appendages, which in many living genera, such as Æga, Gammarus, &c., cover the true feet, they have, in this family, been so highly developed as to become locomotive organs—in some genera being fitted for swimming, in others for creeping, and, again, in others, by co-operating with the lateral spines and caudal extremity, for leaping.

In respect to the natural affinities of Trilobites, Zenker has also some observations deserving of notice. They are, he says, at once,

1st. Annelides: since they have a vermiform annulated body, undivided, fin-like feet (as, for example, in the Nereids, namely, in the genus Eumolpe), probably also, no antennæ. Zenker has quoted, however, from the antenniferous annelides.

2nd. Aselli; since they possess scale-like crustaceous rings, many being able, like the Onisci, (Armadillo,) to roll themselves into a ball, and resembling them likewise in appearance.

3rd. Branchiopoda; since they have, like them, an oval outline, frequently also two prolonged fins projecting from the tail, as in the genus Olenus; and further, as their other fins resemble the feet of the Branchiopoda.

4th. Malacostraca; since they possess a large head-plate, or buckler, and in many instances sessile compound eyes.

Indeed, adds Zenker, had not some species of this family compound sessile eyes, "I would not hesitate to class them with Annelides;" but on the whole, it is best to consider them, with Linnæus, as a connecting link of several families, such as the

Onisci, Malacostraca, Annelides, belonging themselves to the apterous insects.

Although it is evident that analogy deduced from the resemblance of some particular organ, common to two animals, cannot in itself form a sufficient basis for deducing a positive affinity between them; yet it must be allowed that the family of Trilobites naturally leads to this wide range of comparison by the many peculiarities it exhibits. Taking, indeed, into consideration the apparent want of antennæ and true feet, and the probable simplicity of the buccal apparatus, it is perhaps not too rash to add to the catalogue of animals, which, through its intervention, may be linked together, the Echinodermata; see, for example, the remarkable pierced wings of the genus Trinucleus, and the still more singular wings of the genus Harpes, which are far more considerable than the articulated body itself, and in general appearance not unlike the rays of an Asterias, though rigid like the crust of an Echinus; nor should it be forgotten that Oken, whose opinions have some weight on the continent, has placed the Echinodermata amongst his annulated animals, in the third order of his seventh class, which is succeeded by the first order of the eighth, or the Aselli.

In a practical sense of even more importance than the proper appreciation of the true affinities of these singular creatures, is the adoption of such a descriptive nomenclature as may enable the naturalist to render the species he describes as intelligible to others as to himself. Dalman and Zenker have endeavoured to form such a nomenclature, and the following terms will be adopted or modified from them:—

1. *Cephalothorax*, or *Buckler*, Scutum capitale, (Dalman.) The whole region of the head, Regio capitalis, (Zenker.)

2. *Glabella,* (Dalman.)—The central division of the cephalothorax, exhibiting in several genera a distinct prolongation of the central thoracic segments into the region of the head, and corresponding, therefore, to the central division or lobe of the body.

3. *Cheeks, genæ,* (Dalman.)—The portions of the cephalothorax, situated at each side, and immediately next to the glabella, commencing at its base and extending upwards, more or less, according to the genera; as the eyes are situated on the cheeks, they must be considered parts of the true head.

4. *Wings, alæ,* (Portlock.)—The term (alæ) Zenker applies to the cheeks. It is here, however, used as designating all that space which surrounds the glabella and cheeks, being, either rounded off at its posterior lateral edges, or angular, or terminated by long flattened horns in some genera, or by rounded spines in others.

5. *Cristæ oculares,* Eyes.—Eye ridges, tubercula vel eminentiæ oculares (Dalman). Cristæ alares (Zenker.) These occur in various positions on the cheeks, either exhibiting the facettes of compound eyes when they are recognised as true eyes, or not exhibiting on their surface any markings when the Trilobites are considered blind. It cannot, however, be safely assumed that any Trilobites, possessing ocular ridges, were blind, because, though the facettes are not perceptible on the petrified surface it is very probable that in such cases they were so very minute, that in a cast from the mould of the eye ridges in a coarse material, they would have left no distinct impression. Some other terms used by Dalman and Zenker, namely, Sulcus verticalis (Dalman), Sulcus cervicalis (Zenker), neck furrow, as applied to the first and deepest furrow at the base of the cephalothorax; Sulcus frontalis (Zenker), a furrow in advance of the glabella; Crista procephalæa (Zenker), a ridge in advance of the frontal furrow; Hypostoma (Dalman), Procephalæum (Zenker), the whole space between the front of the glabella and the frontal margin of the cephalothorax; Sulcus marginalis (Zenker), the marginal furrow, or a furrow which lies within the outer edge or margin of the wings, are terms which may be used, as occasion requires, under particular circumstances, but as they do not designate any marked subdivisions, are of less importance.

6th. *Linea facialis,* Dalman.—Facial or eye line. This line is very distinct in some, indistinct in others, and frequently entirely wanting. It commences at the front margin of the cephalothorax, encloses the margin of the glabella, winds round the eyes, turns inwards and then sidewards and downwards, so as to terminate opposite the bend, called by Pander knee, in the costæ of the thorax. This line is sometimes so strongly marked as to obtain the name of "Sutura facialis, Dalman," and the cephalothorax then separates into portions so distinct that the central one when isolated from the sides may be mistaken for a perfect head, nor is it impossible that such was the case in the supposed head of Asaphus laciniatus, (Dalman,) or in the remarkable head figured by M. Eudes Des Longchamps as Asaphus Brongniartii (Mem. de la Societé Linn, du Calvados, 1825), see also Plate, IX., fig. 1 a, and Plate X., fig. 1. of this work, and it was this tendency to separation which induced Pander to surmise, that when living the animal had also the power of separating them. In those cases where the facial line is thus strongly marked, it seems probable that the glabella and cheeks are fused into one part distinct from the sides or wings, and the termination of this line opposite the knee seems another reason for believing that so much at least of the side members of the thorax as is between the knee line and the axis enters into the composition of the true body, and cannot be excluded from or considered (as by Zenker) formed into true fins or swimming legs. When the glabella and wings are closely connected together, the separation of the crust is so effected as to leave vacant the spaces which were occupied by the oculiferous cheeks, the thoracic crust having, as it would then appear, spread over all that portion of the region of the head not occupied by the cheeks.

7. *Thorax, truncus,* (Dalman) ; *Abdomen,* (Brongniart.)—This is the portion of the body which appears to have admitted of a movement of its parts, the side segments being entirely free at their terminations. It is divided, in most genera, by longitudinal lines, notches, or furrows, into three lobes.

8. *Axal lobe, rhachis.* (Dalman.)—By Zenker supposed to constitute, in itself, the body ; the lines, notches, or furrows, which separate the axis from the lateral lobes, will be called the axal lines, notches, or furrows.

9. *Lateral lobes.*—By Zenker not considered parts of the body, but as solely occupied by the organs of locomotion.

10. *Segments, segmenta,* (Dalman) ; *Annuli,* (Zenker.)—The transverse divisions or segments of the axal lobe.

11. *Pleuripedes,* (Portlock).—Rib-like feet, or feet-like ribs, pleuræ (Dalman) ; *Pinnæ,* (Zenker.)—Zenker considers them as locomotive organs, fins or swimming feet, distinct from the true body. The view adopted here is a more modified one, and was at first that of Zenker, namely, that they correspond to those lateral accessorial plates which may be traced in Ligia, Idotea, &c., are more distinct in Æga, Gammarus, &c., and finally, are

here so highly developed as to become efficient organs of locomotion.

12. *Knee.*—This, as a very useful term, is adopted from Pander; it designates that knee-like bend in the pleuripedes, which is more or less perceptible in most Trilobites between the axal furrows and the extremities of the pleuripedes.

13. *Pygidium*, (Dalman.)—Post abdomen, Brongniart.—The abdominal, or, as it is often called, the caudal shield. In this the axal and lateral lobes are usually anchylosed together, the ends of the lateral segments, or pleuripedes, being no longer free, as in the thorax. In some genera the segments of the axal lobe alone are visible in the pygidium; in others no segments or divisions are perceptible in either the axal or lateral lobes, the pygidium becoming one large shield or crust. It has been supposed that the rim or margin, which in several genera borders the pygidium, was due to a membranaceous expansion, and even generic characters (Asaphus of Brongniart, as distinguished from Calymene), were drawn from the existence, or non-existence, of this supposed membrane. Such is, however, an improbable explanation of the formation of this marginal space, as it is more reasonable to believe that it is owing to the extension of the crust beyond the ends of the side segments, which are soldered into it so as to form one whole. It rarely, indeed, exhibits any of those accidental folds or wrinkles which, in a very yielding membrane, would have almost necessarily occurred; as a distinctive generic character, therefore, this marginal space is only secondary and unimportant, though, when accompanied by certain peculiarities, such as the caudal prolongation in Phacops caudatus, or Phacops longi-caudatus, it becomes useful as a mark of specific difference.

Having now explained those terms which should be used in the description of Trilobites, the question may be asked before that description is commenced—Is there any mode of forming the several genera already established into groups? In respect to the object of this question, Brongniart did no more than establish his five genera, which together constituted one family.

Dalman divided the family of Palæades, or Trilobites, into two sections:—

1. *Palæades genuinæ.*—True Trilobites.
2. *Palæades battoides.*—This section comprising only the

remarkable and anomalous genus Battus, Agnostus (Brongniart); and he further subdivided the first section into 1. *Oculati*, eyed; 2. *Typhlini*, blind.

Milne Edwards adopts the primary divisions of Dalman; but in restoring to the old Brongniartian genera some of the species which had been separated from them by Dalman, he finds it necessary to introduce some other means of avoiding confusion; hence his division of the genus Asaphus into three sections, namely—

1. *Asaphes Articulés.*
2. *Asaphes Anchyloures.*
3. *Asaphes Oniscoides.*

But when the wide differences embraced by the terms of this sectional subdivision are considered, it appears more desirable at once to subdivide the genus into other groups, of equal value as distinct genera, and admitting of more precision of characters, than to leave them linked together in one loosely characterized genus, and then to attempt sectional subdivision, which, though useful in some respects, cannot secure the naturalist from incongruous combinations; and to follow the same principle with Calymene and other genera.

Considering, then, the Trilobites as constituting a distinct order, or even sub-class—if, indeed, some do not belong to one order and some to another—and the points of connexion between them and recent crustacea, to be the genus Apus on one side, and the Cymothoida on the other, whilst by the introduction of spines as organs of locomotion, and by the peculiar structure of the wings in Trinucleus and Harpes, they approximate to the lower animals, such as the Echinida, it remains to be considered by what genus they approach nearest to the Cymothoida. The resemblance of Asaphus, and still more of Paradoxides, to the recent genus Serolis, has already been discussed; but it is remarkable, as was observed by Wahlenberg, that in the greater proportion of living crustacea of this family the central lobe is wider than the sides, whereas, in the fossil crustacea, the sides of Paradoxides and Asaphus greatly exceed in breadth the central lobe. Such, however, is not universally the case, as in the Paradoxides scarabæoides, (Brong.), Entomostracites scarabæoides (Wahl.), the side lobes are small in proportion to the central lobe. This remarkable species seems to have been only noticed by Wahlenberg, and if allowed to remain in the genus Paradoxides, would require a modification of that portion of the generic characters which represents the flanks as large in comparison to the middle lobe; but it seems more desirable to consider it as belonging to a distinct genus, intermediate between Paradoxides and the Cymothoida; and this opinion is strengthened by the discovery of other Trilobites possessing nearly similar characters, which will be now described. These it is proposed to form into a new genus, Remopleurides, from their paddle-shaped ribs, or costæ.

Genus—REMOPLEURIDES, (Portlock,) *Paddle-sided Trilobite.*

CEPHALOTHORAX.—1st, *Glabella*, central or true cephalic portion, nearly circular, or oval, having in front a lip-like projection, which was probably removable to and from the body (see Pl. I., fig. 4, where the edge is visible), and behind, on each side, a slight indentation, the space between appearing like a short neck-like process, the sides rounded, the surface flattened, but convex. 2nd, *Cheeks*, composed of a very narrow arched band, abutting at one end on the first articulated segment of the body, and at the other against the projecting lip. 3rd, *Wings* triangular, not passing the lip in front, and prolonged backwards into a spine. 4th, *Eyes*. Of these there are no signs on the flattened central portion of the head, but they may have occupied the notches or indentations in the back of the head, where, in some specimens, small oval projections appear, bounded by the arched marginal bands, to the ends of which they give the appearance of blunt-nobs; it is most probable, however, that there were no reticulated eyes.

THORAX.—Number of articulations, including the first, which appears a true thoracic segment, and the last, which is a small caudal segment, thirteen. The central lobe variable in proportions, sometimes twice as wide as the side lobes or plates. Body tapering from the head to the tail. *Pleuripedes* imbricated, resembling in form the paddles, or fins, of the Delphinida, from which resemblance the name of the genus has been taken. They are strengthened on their anterior edge by a raised rib, and at their connections with the central lobe exhibit a knob-like process, as if one of articulation, Pl. I., figs. 1 b, 2 b, 3 b.

Having thus laid down what appears the true generic characters of these Trilobites, some remarks may be offered on their affinities with living crustacea, as far as external form can be admitted as a guide to their determination. That they approach nearer to the Cymothoida than any Trilobites hitherto described, is apparent, and that approximation is even strengthened by an analysis of the relations between them.

The three-fold division of the articulations of the body is common to both the Isopoda and the Amphipoda; but it is variable in degree, sometimes as in Ligia and Idotea, appearing as if the several articulated plates were composed of three portions, and at others as in Gammarus and Ægа, appearing as if the side plates were distinct appendages. There is even a gradation in these differences, the three parts in Ligia, being firmly consolidated together, whereas in Idotea they may be separated; and such is also the case with the side plates of Ægа, and it is therefore with them that the side plates of Remopleurides may be best compared.

The number of articulations in the recent genera is variable. In Idotea there are only ten; in Ligia and Ægа thirteen, a number corresponding, as has been shown, to the number in Remopleurides. The form of the first joint in Ægа is remarkable; though not at its sides so much advanced forward as in Ligia and Idotea, it, nevertheless, is advanced, and when the animal is slightly bent (a very common position), passes over and hides part of the eye. It is further distinguished by a spiniform process, cemented to, and forming part of, its side margin. This suggests the possibility that, though here intimately united to the segment, this appendage may be the type of the wings, or side portions of the buckler of the Trilobites; and hence that, so far from all the Trilobites differing from the Cymothoida, as argued by Wahlenberg, in the first segment not embracing, as it were, the head, the genus Remopleurides exhibits that peculiar structure in a still more striking manner, the sides of the first segment being so modified and developed as to embrace two-thirds of the head; and hence that segment, with its abutting narrow arched bands and triangular spiniform wings, may even be considered thoracic in the generic description of Remopleurides, the central or true cephalic portion of buckler being, in general appearance, not unlike the head of the the Cymothoida.

In the Isopoda, the segments of the body to which the feet are attached, and which may therefore be considered thoracic, are readily distinguishable from those which constitute the abdomen. In Remopleurides, there is no palpable difference between the segments (excepting only the first and last); and hence it is the more reasonable to consider the first thoracic, and all the others abdominal. If this view be correct, the diminution of the number of thoracic segments and the absence of true feet, combined with the extension of the abdomen, the remarkable form of the side plates and the apparent membranaceous expansion around the caudal extremity (corresponding to the caudal appendages in Ægа, &c.), leads to the belief that the side plates have, in this genus, been modified into swimming organs, whilst it is also probable that the spines of the thoracic wings have supplied the place of feet in attaching the animal (if parasitic) to its prey, as in other genera they may have contributed, as already suggested, to the furtherance of locomotion.

In determining the species of this remarkable genus, some difficulty is necessarily felt, both from the uncertainty of sexual differences in fossil crustacea, and from the equal uncertainty of possessing, in any specimen, all the parts which may have originally belonged to it. Making allowance, however, for this difficulty, five species may be described as at least provisionally distinct.

1. REMOPLEURIDES, *Colbii*, (Portlock.) Pl. I., fig. 1. *Glabella*, or central portion of buckler, wider than long; projection, or lip in front, not prominent; notches behind slight; wing spines rather long and sharp. THORAX AND ABDOMEN; each central segment (fig. 1 a) ornamented with a row of small knobs or tubercles along its posterior margin, and finely striated in the transverse direction. None of the side paddle-shaped plates prolonged in spines; caudal segment small and slightly notched.

This was the first tolerably perfect specimen found, and it is called after the Superintendent of the Survey, to whom is due the idea of connecting a geological with the ordinary topographical survey of Ireland.

2. *R. lateri-spinifer*, (Portlock.)—Pl. I., fig. 2. *Glabella*, wider than long; lip, or front projection, rounded and prominent when seen in profile; notches behind very slight; *Wings* ending in a short spine. THORAX, posterior margin of central segments ornamented by knobs or tubercles, but it is doubtful whether they extend entirely across; the *pleuripedes* opposite the eighth central segment prolonged in thick spines; caudal segment (fig. 2 c), if viewed behind, appears strongly notched; but this appears, in part, due to the extension of the side plates, and there seems to be another probably membranaceous appendage forming an outer rim.

3. *R. dorso-spinifer*. Pl. I., fig. 3 a. *Glabella* rather wider than long; lip, or front projection, distinct; notches behind quite distinct, so as to form a short neck. *Cheeks* or cephalothoracic arcs grooved; wings ending in a long spine (fig. 3 e), the surface of which was striated. THORAX AND ABDOMEN; central segments (fig. 3 b) ornamented near their ends with three knobs or tubercles; the ends are wider than the central portion; from the upper surface of the ninth segment projects a long striated spine (fig. 3 d); the *pleuripedes* are longitudinally striated in the flat or membranaceous portion; caudal segment blunt and rounded, having a striated external margin, (fig. 3 c).

4. *R. longi-capitatus* (fig. 5.) The *Glabella* in this species is longer than wide, and the lip projection occupying a larger space than in the preceding species produces a contraction at about one-third of its length from the front; the contraction behind is strongly marked. The first, or thoracic segment, is finely striated longitudinally. No other portion of this species has yet been found. This form strongly contrasts with fig. 4, which is the cephalothorax of probably fig. 3.

5. *R. longi-costatus* (Pl. I., fig. 6.) This diverges from the preceding in the greater width of the lateral lobes, or greater length of the pleuripedes. *Glabella* large, rather wider than long, smooth, with creases; lip wide, equal to at least three-fourths of the width of the glabella; basal contraction, or notches, strongly marked; cheeks, from the greater width of the lateral lobes, tolerably large, and the wings or spines strong, striated, and extending backwards to the eighth or ninth segment. The posterior portion of this specimen is unfortunately imperfect, but it must have been a very beautiful species, and twice as large as either of the three first.

Locality of all the Remopleurides, Tyrone, *Desertcreat parish*, coarse schists.

CERAURUS—(Green).—CERAURUS *globiceps*—(Nob.) Pl. I., fig. 7 a.

The propriety of separating this genus from Paradoxides has been doubted, and if the cast (as given by Green) be strictly correct, some modification of its characters is certainly necessary, as that cast affords no sufficient data for the form of the head assumed in Green's description. Several specimens have been found, though none quite perfect; the one now to be described, exhibits the flattened form and caudal spines of Ceraurus. The pleuripedes as in that genus are divisible into two parts; the first, or nearest to the axis, is in this species plain and single; the second, is marked by a raised fold (fig. 7 c), which may, as in Remopleurides, have strengthened a moveable and membranaceous appendage; it is at this point of separation that the row of tubercles appears in Green's species, and some trace of such tubercles may be discerned even in this. The cephalothorax or buckler, differs strikingly from that of Paradoxides; its central portion or glabella, is projecting and globose in front, and is narrowed posteriorly into a kind of neck. The cheeks are slightly convex, extend upwards a little beyond the neck, are triangular, and terminate backwards in spines; the eyes appear to have been at the apex of the cheeks (fig. 7, b) The caudal extremity is rounded. The number of segments appears at least thirteen. The side lobes are nearly three times as wide as the central portion, or axis; the first, or shortest spine, corresponds to the tenth segment, the longer spine to the twelfth. If other species should be found, equally differing from Paradoxides in the form of the head which approaches more closely to that of Trinucleus, as may be seen by referring to that genus, new and more satisfactory generic characters than those given by Green will be required: in that case the form of glabella, here made a specific character, may prove a generic one. There is some resemblance between the abdominal portion of this fossil and Paradoxides quadrimucronatus.

PARADOXIDES—*Paradoxides ? Bucephali*—(Var.) Pl. I., fig. 8.

The two individuals which are referred to this genus and species (the Entomostracites Bucephali of Wahlenberg), are very obscure fossils. They occur of somewhat different sizes, but always the same in form; the sides of the supposed buckler being elongated in thick rounded spiniform projections; and the central portion at its base being strongly wrinkled. There can be little doubt that these are portions of heads or bucklers; but as yet no other corresponding part of the animal has been discovered.

Genus—AMPYX—(Dalman).

"Eyes not apparent, nor even protuberances in their places, but rather impressions; head, large and triangular: glabella, very large, prominent, gibbous, and not lobed; body, short with few segments (6); pygidium, distinct and entire." Milne Edwards enumerates the segments of the thorax as from five to six; Sars as five in reference to the species he describes.

To these characters which are in themselves sufficiently distinctive, may be added the following:—Body, when expanded, very flat; side costæ (Pl. I., fig. 9 b) grooved in the direction of their length, and forked at their ends, but not exhibiting the compound structure of those of Phacops, Calymene, &c. In the latter it would appear that when the animal rolled itself up, the ends of the pleuripedes slipped over each other so as to approximate to the common centre of the external curve, like the fixed ends of the rays of a fan; in Ampyx this was not the case, and the animal seems to have simply doubled up its pygidium under the front part of its thorax, without any sliding of the costæ of the thoracic segments on each other, a peculiarity of structure by which this genus is widely separated from Asaphus and Calymene, on the one side, and approximated to the genus Trinucleus on the other.

AMPYX *rostratus*—(Sars).

As the species found in the fossiliferous schists of Tyrone is either identical with, or closely related to, the species described by Sars, in the

"Isis von Oken," under the above name, it is necessary, for comparison, to quote his description and remarks.—(Isis, 1835, pages 333, 334, 335.)

"The long horn in front of the glabella, gives to the small, moderately broad and rounded Trilobite (see Isis, 1835, Pl. VIII., fig. 3,) a most strange appearance: in respect to which it deviates entirely from all other species hitherto known, and exhibits also a new form in the series of the obscure animals of a former world. Amongst known species it resembles most the Ampyx nasutus of Dalman, although at once distinguished from it by the conical lengthened glabella with a high ridge or crest, visible along its middle, which stretches out into a long, thin, awl-shaped horn, which is sometimes longer than the buckler, though, with reason I might conjecture, that Ampyx nasutus had also a similar horn, because such a structure is clearly found in another species very little removed from A. nasutus, if not identical with it, which I shall presently describe. Yet, on the other hand, the form, as described, of the glabella, together with the entire want in the present species of side impressions or furrows at its base, afford sufficient marks for subdivision. In the best preserved specimen may be seen all round the head a margin or border, which, at the posterior angles on each side, stretches out into a horn or spine, the length of which cannot be determined as both have been broken off. The body consists of five segments; the middle lobe is tolerably broad and not much raised; the side lobes are also broad. Each segment is marked by a deep transverse groove. Dalman's A. nasutus has, according to his enumeration, six segments; since, therefore, the foregoing species had probably the same normal number of segments, one of them (which is not uncommon in Trilobites) may have been pushed, or hidden, under the others; but this I am not able to determine, as I have only obtained one perfect specimen. The caudal shield (pygidium) is half-moon shaped, and its margin behind is provided with a thick rim which turns under and is streaked longitudinally; the middle lobe is tolerably broad, slightly raised, smooth, without trace of segments or transverse furrows, but instead of them has six transverse rows of round, rather flat, and very small knobs, four in each row, which mark the segments; the side lobes are entirely smooth, having only in front, two characteristic lateral furrows; the caudal shield, therefore, is also well distinguished in this species. It will be seen how close an affinity exists between this species, as well as the following (A. mammillatus), and A. nasutus of Dalman; it is doubtless, therefore, most proper to separate them from the genus Asaphus, from which they widely differ in the total want of eyes, in the small number of segments, and the lengthened conical form of the glabella. They all three form a very well marked group, which should bear the name of Ampyx, first bestowed on it. It is even probable that Asaphus granulatus should be included in the group, which it resembles in every respect; its body having six segments, as I have satisfied myself from perfect specimens obtained from our rocks; and the more so, as I have discovered in many specimens a small circular nipple, which seems the trace of a thin spine which had doubtless been broken off. Ampyx rostratus occurs in our common black transition limestone near Cristianiana, associated with numerous species of Asaphus, Calymene, and of Orthoceratites, Lituites, and Shells of Gasteropoda."

If the conjecture of Sars be well founded (and in all probability it is), that Ampyx nasutus was provided with a frontal spine, it is equally probable that if perfect it would have exhibited lateral buckler spines also, and hence that these appendages must be considered rather generic than specific distinctions. As the terms *nasutus* and *rostratus* are therefore inappropriate as specific designations, they should be replaced by others not tending to confound generic with specific characters, and A. nasutus might be called, after its discoverer, Ampyx Dalmanni; A. rostratus, Ampyx Sarsii. Whether Ampyx mammillatus (Sars) be really distinct from A. nasutus, seems even doubtful to Sars himself; its distinguishing peculiarity he thus states, "At the base of the glabella on each side, there is a tolerably large and oval-flat elevation, bounded above, below, and on the sides by furrows, with a smaller furrow on the middle;" this, as he observes, is not apparent in Dalman's figure, but there certainly are in that figure two remarkable spots or marks which correspond exactly in position with the upper and lower furrows of Sars, hence it is more than probable that direct comparison will prove these species to be the same.

AMPYX Sarsii, Portlock—Ampyx rostratus—(Sars), may be thus characterized.

Glabella,—ridged or keeled longitudinally, projecting about one-third of its whole length beyond the junction with the cheeks.

PYGIDIUM,—entire; axal lobe slightly raised and marked by six rows of small knobs or tubercles, four in each row, corresponding to the concealed segments; lateral lobes flat, and marked near their top on each side by two furrows; extremity rounded so that the form of the pygidium, as a whole, is semi-circular.

AMPYX *Sarsii*—(Portlock) Var. } Pl. I., figs. 9, 10.
AMPYX *rostratus*—(Sars) Var. }

General form of CEPHALOTHORAX, triangular. *Glabella* long, contracted posteriorly, acuminated anteriorly, and terminated by a long spine; it is marked more or less distinctly by a central ridge, as in fig. 9 a. *Cheeks* smooth, extending to about one-half the height of the glabella, having a small puncture at the junction; laterally prolonged in long spines. PYGIDIUM; axal lobe faintly marked by lines of division; sides smooth, with one furrow. They are sometimes found doubled up, as in fig. 10 b, where a triangular portion of the lower surface of the glabella is seen, on which there is a transverse line, marking, it would appear, a division into two parts. This species is distinguished from Sars' figures of A. rostratus, particularly his fig. 3 b, by the position of the cheeks in respect to the glabella, which they meet at about half its height, and not so near the point as in his species; but in this respect there is considerable variation even in Sars' figures. His description of the abdomen, however, "no traces of segments but six rows of very small tubercles, four in each row, which mark out the segments," will scarcely suit our specimens in which there are segments, though certainly very faintly marked; but it is probable that these appearances depend much upon the condition of the surface.

AMPYX *Austinii*—(Portlock) } Pl. I. B, figs. 1, 2.
AMPYX *mammillatus?*—fig. 4 c, (Sars.) }

The peculiarities of the species of Sars, as defined by him (Isis, 1835, page 335,) are, that at the base of the glabella there is a projection on each side bounded by furrows and having a smaller furrow in the middle. These furrows seem analogous to those of the genus Phacops, hereafter to be described, and are quite distinct in our specimens. The glabella is represented in one figure, blunt in front, less so in another, and elongated in a third: and it is very doubtful whether these are really the same species. At the front point of the glabella, in figs. 4 a and 4 c, a small mammillary tubercle appears, which Sars, however, conjectures may have been prolonged in a rostral spine; and in like manner he thinks it certain that the cheeks terminated laterally in spines, as, in A. rostratus. Of the abdomen, which was not found in direct connexion with the thorax, he observes, that the axal lobe is marked by numerous transverse striæ, and the sides faintly striated, that there is a deep furrow at the front margin, and that the general form is triangular. Comparing these remarks with the two specimens from Tramore, the following description may be added: CEPHALOTHORAX regularly curved anteriorly and laterally, being less than a semi-circle; *glabella* gibbous, larger in front than posteriorly, extending to the front of the cephalothorax, and quite blunt; marked at the base by two distinct furrows, and close to the neck by a fainter; the rostral spine proceeds from the upper front point of the glabella; transverse basal furrow of the cephalothorax strongly marked; cheeks terminating in spines. THORAX, six segments exposed. PYGIDIUM, triangular, transverse; upper furrows strong; axal lobe marked by segments; sides in these specimens smooth. Dedicated to Major Austin, who contributed the specimens, for illustration; they were collected by him at Tramore, Waterford.

AMPYX ? *baccatus*—(Portlock,) Pl. III., fig. 11.

CEPHALOTHORAX, triangular; rounded in front and terminating posteriorly and laterally in spines. *Glabella*, moderately convex; rounded in fornt and narrowed behind. *Cheeks*, only slightly raised, without any distinct oculiform tubercles. Glabella, ornamented by a very highly developed rim of tubercles, like beads or pearls; hence the specific name. The whole surface is also more finely tubercular. Two of the tubercles on the cheeks are large like those of the rim, and occupy the place of oculiform tubercles; this is seen on the left cheek of the figure, that on the right had been obliterated. There is no appearance on this specimen of a rostral spine, and I was at first inclined to associate the specimen with Calymene variolaris; but a careful comparison induces me to consider it more nearly allied to this, than to any other genus. Only this one specimen discovered.

TRINUCLEUS—(Name revived by Murchison, from Llwyd)—CRYPTOLITHUS of Green.

This name, used by Llwyd in the same sense as that of Trilobite, was subsequently used by Parkinson, received from its founder no generical definition, although the individual represented evidently belonged to this now defined genus. Green's definition of Cryptolithus is: " Body, contractile; buckler, lunate, convex; outer edge surrounded by a semi-circular, reticulated or tesselated border. Front or middle lobe of the buckler very protuberant; oculiferous protuberances, none. Abdomen much compressed, trilobate." Mr. Murchison thus defines it: " Caput obtusum, scutum versus marginem punctulis concavis ex ordine collocatis ornatum, trilobum: lobis rotundato-protuberantibus, medio lateralibus minore. Corpus breve, 5—7, costatum (the ribs are six); costis lateralibus rectis. Pygidium trilobatum breve."

TRINUCLEUS *Caractaci*—(Murchison)—Pl. I. B, fig. 3 a.

Murchison's specific characters are, " Marginal pores of the shield in concentric rows (5 and 6) in the front, on the sides scattered and terminated laterally by a plain, slender, pointed cheek or spike, which extends beyond the body. Caudal furrows, five on each side. Tail obtusely mucronated." Notwithstanding that in our specimens the rows of punctures are never so numerous in front as they are described by Mr. Murchison, I am induced, from the general similarity of form, to ascribe the specimens represented, figs. 3, 4, 5, to this species. A careful comparison of the several figures will show that on the sides there is no difference between them and Mr. Murchison's; and as in our specimens the rows nearest the cheeks are blocked out by the glabella, fig. 5, so as to reduce them in front to three, it is most probable that as a general rule such was the case also with the English specimens, and this was my impression on examining those specimens. In the specimen fig. 3 a, the side spines are lost, but in others they are present. To the former descriptions may be added; *Glabella* gibbous, very swollen in front, thick but narrowed at the base; *cheeks* ample and rounded, but varying in form, being sometimes more extended laterally, as in fig. 4, than at others. Thorax and pygidium taken together, shorter than the width of the body. PYGIDIUM rounded or blunt behind.

TRINUCLEUS *elongatus*—(Portlock)—Pl. I. B, fig. 7.

In most of its characters this agrees with the last; but it is more elongated, the length exceeding the breadth. The *glabella* is narrower, particularly at the base, corresponding to a narrower axal lobe; the wing spines are long, extending far beyond the body. The PYGIDIUM is proportionably longer and less rounded; the axal furrows are faint, and in number about seven; the pleuripedes marked by a faint line or furrow.

Fig. 6 is intermediate in some of the characters between T. Caractaci and T. elongatus; but by the narrow axal lobe and length exceeding the breadth, it approximates to the latter. This is nearer Green's species Cryptolithus tesselatus, but his figure is insufficient for identification; it also approximates in form to Murchison's T. nudus, which possibly only wants the ornamental portion of the buckler by accident.

TRINUCLEUS (Asaphus, Hisinger,) *seticornis* (Hisinger), Pl. I. B, fig. 8.

In this species, which probably will hereafter become the type of a new genus, the lobes of the cephalothorax are very strongly marked, the glabella being separated from the cheeks by a deep furrow. *Glabella* very prominent and globose; at the base obscurely lobed as in Phacops (Hisinger says three-lobed, which including the neck joint it is); cheeks elevated, and having on each a minute (ocular ?) tubercle, which appears in Hisinger's figure, though it is not noticed by him. General form oval; the PYGIDIUM being short and rounded with a flat curve.

Hisinger has a second species, Trinucleus (Asaphus) Cyllarus, which he distinguishes as being bi-lobed at the base of the glabella, and having blunt wings; this latter character is doubtful, as imperfect specimens have often an appearance of wanting the lateral spines; but the shorter neck may perhaps be sufficient to separate them. The furrow, which in Hisinger's figure divides the rows of cephalothorax punctures nearest the cheeks and the glabella from the marginal rows, is visible in some of our specimens, but not in all; it is not, therefore a constant character. It is probable that the cephalothorax represented in the middle of Murchison's, fig. 2, Pl. 23, belongs to this species, as it has all the essential characters, being lobed at the base of the glabella, and having the small oculiform tubercles; it appears to differ from the other figures named T. fimbriatus. Hisinger's locality is transition slate of Furndal and Dragga, in Dalecarlia.

TRINUCLEUS *radiatus*?—(Murchison)—Pl. I. B, fig. 9.

This is closely allied to the preceding, but the *glabella* is narrower and more oval, the neck very short, the cheeks are proportionately wider, and the ocular tubercles are close to the dividing furrow. The *wings* are highly developed and have a prominent rim; the radiation of the lines of punctures is sometimes more striking than at others.

TRINUCLEUS *fimbriatus*—(Murchison.) } Pl. I. B, figs. 11, 12.
TRINUCLEUS *latus*—(Portlock.)

Characterized as having the margin of the wings fimbriated by the lines of punctures. In the figures given in the Silurian system (Pl. 23, fig. 2), those marked a and b, appear to belong to this species; the other figure in all probability belonged to T. seticornis. In fig. b the glabella has evidently been broad, and the cephalothorax generally short, as compared to its breadth; the fimbriation of the margin is the result of an imperfectly developed rim which is often scarcely perceptible. In the specimens I refer to this species, and which I had heretofore called T. latus, the side spines are deficient, but in another and larger specimen they are present, and I only consider their absence as the result of mutilation. The very short and wide cephalothorax seems characteristic. The punctures are in the usual number of rows (three in front), but being crowded together the margin becomes very narrow.

Pl. I. B, fig. 10.—This is intermediate in characters between T. elongatus, and T. fimbriatus, the rim of the wings is very slight; the glabella is oval, being longer than wide. Though the specimen is imperfect, it has evidently had spines projecting laterally as in fig. 9.

Figs. 13 and 14.—Abnormal specimens in which the glabella is very gibbose; they are merely figured to show the variations of form, as the want of other parts will not admit of their correct allocation.

Pl. I. B, fig. 15.—Is a pygidium of very large size, but it is, of course, impossible to name the species from that part alone.

The following remarks may be added in respect to some peculiarities of structure. The casts of the wings are sometimes punctured in the manner described, and sometimes marked by rows of fine tubercles, and this difference occurs in the same species. The impressions, as in fig. 5 a, (magnified in 5 b,) are also marked by tubercles. Now the explanation of this may be found in the particular condition of the specimen, as in fig. 16, and fig. 17, where a portion of the crust has been preserved, it is evident that the punctures have produced tubercular casts on the one side, which in fig. 17 (though this may be an accidental circumstance) appear punctured or truncated, and that the opposite side of the crust might in like manner have produced similar tubercular casts, so that an impression and a raised cast would indiscriminately exhibit the same appearance. And again, a cast from either of these tuberculated impressions would exhibit depressions corresponding to the original punctures. On this view of the subject, the punctures of the crust would appear to have been narrowed inwards, or those of the opposite surfaces to be cups joined base to base. The thoracic segments are six in number; the pleuripedes are (fig. 3 b) duplex, as in Phacops, and, as well as the pygidium, were remarkably flat. The pygidium was terminated by a narrow vertical margin or flap.

HARPES—(Goldfuss),

Is thus characterized by Goldfuss :—The body is extended, the elevated eye tubercles have no reticulated surfaces, but several, regularly arranged, large and small wart-like prominences. The middle body consists of twenty equal segments, which on the axal lobe are convex, on the lateral lobes flat, furrowed, and even. The tail segments are not separated, and the body probably ends with a small terminal segment. This genus, therefore, is nearest allied to Olenus (Paradoxides), but is separated from it by the possession of eyes; and whilst, in that genus, the species have either 14 or 21 segments, the number seven is here quadrupled.

Such are the only characters assigned as generic to this Trilobite; but in the specific characters of Goldfuss' only species, H. Macrocephalus, the remarkable rim or band which surrounds the cephalothorax, and which ought to form part of the generic characters, is thus mentioned :—"It (the head) has a semi-circular contour, and is surrounded by a broad rim, which is horizontal in front, but gradually assumes, on each side, a perpendicular position, and extends, on each side, into a spine prolonged backwards to the last quarter of the body. Its rim is somewhat thickened, and forms above, as well as upon its under fold, a raised border. Rising out of this horse-shoe-like margin, the head is arched forwards and sidewards, somewhat high and steep, and has in the middle of its height a high oval frontal eminence (Glabella), which is bounded by an impressed furrow, and does not descend to the rim. It is keeled at top, and has a slight fold in front of the vertical furrow. Close to its anterior extremity, there is, on each of the large wings, (cheeks), a small semi-circular eye-tubercle, on which can be distinguished, with the naked eye, one large round wart in the middle, and two oval warts, of similar size, on the sides; and between them, by the aid of a lens, may be discovered many other smaller warts in regular arrangement. The hind part of the head ends with a swollen small half ring, to which the members of the middle body (thorax) are joined. The frontal eminence, and the top of the cheeks above the eyes, are smooth, some small granules only being visible on the summit of the former; the whole remaining surface of the head is thickly granular, whereby the boundary of the smooth front is sharply marked. The marginal rim plate is on both its upper and under surfaces, and at its inner and outer edge, prettily bordered by a row of large granules. From the head to the extremity of the tail there are 28 segments, which become gradually and similarly shorter towards the end. Whether there is a small simple caudal plate, without segments, cannot be determined from the specimens. The highly convex axal lobe is one-third of the whole breadth, and its segments are annularly convex, whilst the ribs have a very shallow longitudinal furrow, lie close to each other, and form an even lateral surface. The short ends are blunt, and bent at an angle downwards, so that the body possesses a small marginal border. The front ribs increase gradually in length till the seventh or eighth; whence to the end they again gradually diminish. The axal lobe is granular; the sides quite smooth."

Such are the characters assigned by Goldfuss to his only species of this very singular genus, and it has been necessary to quote them at large in order to judge how far they are truly specific, and what portion should be transferred to the characters of the genus—a transposition which it is now possible to make, as two other Irish species have been discovered. The remarkable horse-shoe form of the marginal rim first drew attention to this genus, impressions of its under surface being very common. The subsequent discovery of numerous specimens exhibiting the cephalothorax and the pygidium, gave a tolerably clear idea of the animal, on which it was intended to bestow a name characteristic of its peculiar form. Goldfuss having, however, named the genus in Vol. 19, Part 1, of Nova Acta Acad. Cæs. Naturæ Curiosorum, his name is here adopted.

Of his specific description, the large horse-shoe formed cephalothoracic wings, and the principal characters assigned to the glabella and cheeks, should be generic, though in the Irish specimens the existence of the very anomalous eyes, described by Goldfuss, cannot, with certainty, be affirmed, imperfect traces only being visible, of something like them, but not in the same position. The position, indeed, assigned by Goldfuss to these pseudo-eyes is at present unexampled in the family of Trilobites, and it is therefore not improbable that, if really organs of vision, they are merely supplementary to other eyes. The genus will, therefore, be thus characterized.

HARPES—(Goldfuss.)

CEPHALOTHORAX.—Composed of the parts common to most Trilobites, and in addition to them, of a large horse-shoe-formed marginal plate.

Glabella.—Imperfectly oval, being wider in front than at the base; convex, and ridged down the middle; at its base one cephalothoracic segment, swelling out at the sides into wide expansions so as to have a triangular form. A furrow, corresponding in some respects, to the usual eye line, commences at less than one-third from the front of the glabella, forms part of a small circle, and unites with another curved line which blends into the neck furrow; the portion of the cheeks within these curved lines is, as it were, sunk or depressed; and it is very probable that true eyes, if they really existed, were on some part of this compound line; the traces of the false eyes are external, and close to the upper of the two circles.

Cheeks.—The portion external to the supposed eye lines are gently convex, blending with wings which are bent down perpendicularly, and taper off to a point backwards. They join at their under margin a flat, wide, horse-shoe-formed rim, or plate, constituting the chief peculiarity of the genus. The cheeks as far as the eye lines, the wings, and the horse-shoe marginal plate, are granular, the latter with a row of larger grains or beads along the external margin.

THORAX AND PYGIDIUM.—Consisting, according to Goldfuss, of 28 segments, and probably of a small caudal plate. This number cannot be verified by the Irish specimens, as they are all partly rolled up and imperfect. Axal lobe at least one-third of the whole breadth; side segments longitudinally furrowed, and slightly bent at the ends; caudal plate very short, triangular, and slightly furrowed.

I place the genus in connection with Trinucleus, to which it appears to have the strongest affinity. The two Irish species are named after the highly intelligent and indefatigable collectors, to whose zeal and ability this work is greatly indebted.

HARPES, *Doranni*—(Portlock,) Pl. V., figs. 4 a, 4 b, 4 c.

The length of the cephalothorax, exclusive of the marginal plate, is less than one-fourth of the whole length of the horse-shoe; total breadth of horse-shoe, as compared to its length, 4 to 6½, or 8 to 13. Breadth of the horse-shoe plate to its total length, about 1 to 9. The horse-shoe is rounded in front, and its ends are bent inwards, so as almost to meet. There is a distinct furrow at the meeting of the wings, or vertical portion of the margin, and of the horizontal horse-shoe plate. Thorax, &c., deficient. Total length of horse-shoe, 1·4 inch. Dedicated to Patrick Doran.

HARPES, *Flanaganni*—(Portlock,) Pl. V., figs. 5 a, 5 b, 6, 7.

CEPHALOTHORAX; length, exclusive of marginal plate, one-third of the whole length of the horse-shoe. Total breadth of horse-shoe, as compared to its length, 6 to 7½, or 12 to 15; sometimes even less, or 6 to 7. Breadth of horse-shoe plate to its total length, 1 to 4. The curve of the horse-shoe is much flattened in front, both externally and internally, and the inner margin of the sides being quite straight, gives them parallelism within, whilst the outer margin curves inwards and downwards, and meets the inner at a point. The horse-shoe form is, therefore, here complete, and has a squareness and shortness of outline not exhibited by the preceding species. For thorax, &c., see generic characters. Dedicated to James Flanagan, as distinguished for his integrity as for his ability and untiring zeal.

In Goldfuss' species the length of the cephalothorax is to the total length of the horse-shoe as 1 to 3; the total breadth of the horse-shoe to its total length, 11 to 17; it is therefore not so square in form as H. Flanaganni, more particularly as the inner margins are not parallel, but incline towards the outer.

In the specimens figured (fig. 7), it will be seen that the animal was accustomed to double itself up, the abdominal extremity fitting into the rounded internal margin of the horse-shoe. Fig. 5 b is restored, in order to show its appearance. Fig. 6 is slightly varied from fig. 5.

BRONTES—(Goldfuss.)

Goldfuss characterizes this genus as follows:—"The head is quadrilateral, and slightly convex; the eyes are kidney-shaped, and probably reticulated; the body is extended, divided by the longitudinal furrows into three parts of equal breadth, and has ten segments—an eleventh segment forms, by its expansion, a large caudal plate. This genus is distinguished from the genus Lichas (Dalman) by its undivided caudal plate, from Olenus by the outspreading margin of that plate, and by the square-shaped head from all other Trilobites provided with eyes. On a mere superficial examination, it has even some resemblance to those species of the genera Asaphus, Nileus, and Illænus, of which the segments of the tail are united or anchylosed together; but it is never, like them, rolled up. Through the number of its segments it is related to Illænus. We know only one species the caudal plates of which are often found in the transition limestone of the Eifel, whilst perfect bodies are extremely rare."

Such are Goldfuss' remarks on the genus. One point of difference between it and Asaphus, &c., that it does not occur rolled up, must be rejected, as the variety observed in the positions of other Trilobites leaves such a negative condition undetermined as a point of fact, whilst there is nothing in the construction of the animal to prove it. The very remarkable form of the head (as in this genus, it may be so called), and of the abdomen, are of themselves quite sufficient to isolate the genus. Of the head and thorax, no specimens have, as yet, been found in Ireland, but of the pygidium several have been obtained. Under these circumstances, it would be rash to pronounce a decided opinion on the head described by Goldfuss, although it has much the appearance of being merely the central portion, viz., the glabella and internal cheeks up to the eye line, the external portion including the wings being deficient. Passing over the first portion of the specific description of Brontes flabellifer (Goldfuss), the caudal flap is thus described: —" Of the caudal flap, the axal segment is not smaller than those of the thorax, and is bluntly rounded behind; its flat, convex, shield-like expansion is somewhat bent upwards at the margin, and is divided by 16 radiating furrows, either narrow or broad, into flatly convex, either broad or narrow, ribs. Small caudal flaps have the furrows narrow; in those of a medium size they are sometimes narrow, sometimes broad, and in large specimens they are as broad as the ribs. The shell (crust) of the caudal expansion is from the margin turned inwards, and this doubled over portion is much thicker than the easily peeling off outer layer, lies close to it, and exhibits concentric lines of growth. The impressed radiating furrows are on its upper surface scarcely observable, and on the under entirely lost. Goldfuss, in this description, speaks of 16 caudal furrows; in his plates there appear only 14, and the number of ribs is 15, including the central one. The surface of the caudal cast, on removing the crust is stated to exhibit concentric lines, which Goldfuss considers lines of growth. The Irish specimens suggest some remarks on the description of Goldfuss. The portion represented by him as terminating the axal lobe, and as being rounded and blunt posteriorly, so as to be quite separated from the central caudal segment or rib does not appear equally separated in the Irish species, in which, though at first contracted, the axal lobe swells out again, and seems to blend into one with the central segment, the same striæ appearing on both. The upper part of this lobe is slightly raised, so as to form a single segment, to which the upper rib on each side corresponds. The number of furrows is 12, the number of lateral segments or ribs on each side 6, or 12 in all; the total number, including the central one, thirteen. All the surfaces visible on the specimens are marked with fine lines; but it is not probable that they are, as supposed by Goldfuss, lines of growth, since those on the upper crust often differ in direction from those beneath it, and some are partly waved, and are not concentric to the external margin. The existence of such lines on the abdominal margins of many Trilobites is observable on the removal of the external crust, or the matter which has replaced it; and they are probably, therefore, in most cases, connected with the under surface, or lining membrane. In Plate V., fig. 8 a; the whole abdomen is represented as seen from above; the upper portion is formed of matter which has either filled up the mould of the upper surface, or been cast in the animal as a mould, it is marked by lines, or as they appear, raised threads, transverse to the segments, but not quite regular. Part of this substance has been peeled off, and the lines below it are seen at the lower portion of the figure; they are oblique to the segments, corresponding in part to the external contour, but towards the margin becoming waved, and not, therefore, so corresponding: these are depressed lines. Pl. V., fig. 8 b exhibits the portion of the axal lobe deficient in fig. a; it also shows portions of the two surfaces. When the abdomen is seen from below, the furrows become sharp ridges.

It is probable, from the less than usually rigid or defined appearance of the segments, that the whole abdomen possessed much flexibility. The difference in the number of furrows and segments, and in the form of the axal lobe, separates this species from that described by Goldfuss; nor can this difference be ascribed to age, as in individuals of the two sizes prevailing amongst the Irish specimens, one being only half that of the other, the same number of segments is visible. It is, however, to be regretted that Goldfuss has adopted the name of Flabellifer, since it is now evident that it has no peculiar application to that species. As a generic appellation, fan-tailed Trilobites would have been highly appropriate. The Irish species is named as being at present peculiar to the Irish strata.

BRONTES *Hibernicus*, Pl. V., fig. 8 a, 8 b.

Length of abdomen, 1·62 inch; breadth of ditto, nearly 2 inches in the large specimens; the form is, therefore, part of an oval; the whole animal would be, in the proportions of Goldfuss' species, $3\frac{3}{4}$ inches in length. These abdominal extremities have also, from their striated appearance, been mistaken for those of the genus Ogygia. The difference between them is, however, very great, as in Ogygia the axal segments are continued into the abdomen, as in the genera Phacops and Calymene, and the form is elongated and pointed; Brongniart's Pl. III, fig. 8, copied from Wahlenberg's Pl. II, figs. 7 and 8, seems referrible to this genus. The head, indeed, being very imperfect in Wahlenberg's Plate, differs considerably from that of Goldfuss: it has, however, a generally square form; the species is thus described by Wahlenberg:—

Entomostracites laticauda; eyes at the sides of the very convex head; tail suborbicular; limb very wide, very flat, entire, radiated; head convex, somewhat oblong; tail more than two inches wide; middle or dorsal portion small, not greater than the nail of the little finger, but little elevated; limb much wider, adorned with superficial radiating folds. By Wahlenberg's figure it would appear that there are four lateral segments, or radiating ribs, on one side, and five on the other; the specimen must, therefore, have been imperfect, or imperfectly drawn, and it is impossible, in consequence, to decide whetner it is or is not another species. Munster also (Beiträge, 1840) describes, from the caudal extremity, four species, and Professor Phillips and Mr. Murchison another, in addition to B. flabellifer. Whether these are all good species is doubtful, but they are quite distinct from the Irish one.

ARGES, (Goldfuss.)

"No trace of eyes; the body is elliptical when extended; the thorax consists probably of eight segments; the tail forms a broad plate, consisting of four segments connected together." One very remarkable species is described by Goldfuss, Arges armatus, the figure of which should be consulted as a means of identifying its fragments if met with in British strata.

The generic characters are far too vague, but at present it would be useless to attempt to reform them here, as no specimens of cephalothorax or thorax have been hitherto found in Ireland. The case is different with the abdomen, if it be correct, as is here proposed, to refer the various specimens named by Murchison, Paradoxides bimucronatus, to this genus. That they should not be referred to Paradoxides, is evident, since, in that genus, the lateral segments continue free almost to the end, the axal lobe being terminated by a short abdominal or caudal extremity, consisting in P. Tessini, of three segments without lateral costæ, whereas the caudal extremity of P. bimucronatus, consisting of axal segments and costæ united together, cannot belong to the same genus.

Goldfuss' figure of the caudal extremity of a young individual of Arges armatus, when strongly magnified, resembles, in general form, that of P. bimucronatus, and more particularly its axal lobe; it is proposed, therefore, to connect the latter with that genus.

ARGES *plano-spinosus*, Pl. V., fig. 9 a, 9 b.

PARADOXIDES bimucronatus, Murchison.

PYGIDIUM.—Axal lobe has four pseudo-segments, and a small mucro at the end; lateral segments, actually four on each side, the two first separate close to the axis, and then flattened into one; the two last united and curving round the mucro of the axis. These three segments, considering the two first as one, are flattened, united together into one whole at their base, but ending free in flattened spines curved backwards.

Genus, NUTTAINIA.

This genus was established by Professor Eaton, to receive two Trilobites which did not appear referrible to any previously established genus. Of these, one has been shown by Dr. Jacob Green to belong to his genus Cryptolithus, (Trinucleus of Murchison); and the other, only a fragment of which was found, remains therefore the sole foundation on which this genus has hitherto rested. As Professor Eaton's generic characters have evidently been drawn from the specimen of Cryptolithus, they cannot represent the true features of the other specimen, which is, indeed, only connected with the Cryptolites through the mistake of Eaton, in supposing the first segment of the thorax to be the anterior rim of the buckler—a mistake which is suggested to be probable by Green, who also suggests the possibility that the head itself may be one of a large Asaph or Ogygia. It is evident, then, that Professor Eaton's data were totally insufficient for the establishment of a new genus, and that Nuttainia must have been abandoned, had not the original fragment been reinforced by other more characteristic parts discovered in the Tyrone schists. The first fragments found were also partly mutilated bucklers and were still insufficient to decide, with certainty, the genus. At length, however, the pygidium, and a mould of nearly the complete animal, were fortunately obtained, and when taken together, they fully establish the individuality of the genus, which, as it is always more desirable in Geology to bring to light coincidences than to foster apparent differences, is here designated by the name bestowed upon the genus by Eaton.

NUTTAINIA.

Generic Characters.—To determine the true generic characters of fossil groups, or those characters which shall be common to a certain number of individuals, there are, as before suggested, great difficulties consequent on a necessarily imperfect knowledge of their true original condition to be overcome, and those increased when only one tolerably perfect species has been discovered, as it is possible that some parts of the structure considered constant and generic may ultimately prove specific, or that some portion considered specific may ultimately prove generic. Were the true functions of the several parts of fossils fully known, such difficulties would disappear; but at present they can only be palliated by caution. In the present genus, the chief peculiarities are to be found in the form of the buckler and structure of the pygidium; on which, therefore, the genus will principally depend.

CEPHALOTHORAX.—Gibbous; marginal outline in front nearly semicircular, behind, if the thoracic segment be included, straight; divided by well marked lines into five principal segments, to which, on each side, may be added an antenniform projecting process, which appears to have been provided with fibrillæ or tentacula, Pl. IV., fig. 1 b.

Eyes.—Doubtful; probably placed on the segment, second from the central lobe of the head.

THORAX.—Segments probably ten, imbricated; the central lobe about equal to the sides, of which the costæ (pleuripedes) appear to have been free at their extremities.

PYGIDIUM.—Very remarkable. It is composed of a centre, which is connected by an articulating segment with the abdomen, and further divided into at least two parts; one, a narrow segment, and the other, or posterior, a large, well developed segment; and of three caudal appendages on each side, which appear to have been free and imbricated, resembling, in a very striking manner, the caudal extremity of the Macrouran genus Galathea.

This alone would distinguish it from any other well characterized genus. In the Entomostracites laciniatus of Wahlenberg (Paradoxides laciniatus, Brongniart; Lichas, Dalman), there is a somewhat similar structure in the caudal segment; but the number of caudal appendages on each side is two, a large undivided one being interposed between the lateral, the whole resembling the caudal segment of the genus Astacus. If, then, Wahlenberg's figure, which differs very much from Dalman's, be strictly correct, his specimen must have belonged to a different, but closely allied genus; and it may, therefore, be doubted whether the head appropriated to it be the real one. His words are; "a perfect specimen we have not as yet seen, but have presumed the head and tail now described to belong to the same species, both being found in the same place and matrix;" and this doubt is strengthened by the fact, that M. Eudes Des Longchamps, in his Memoir on the Fossils of Calvados, appropriates a very similar head to a totally different abdomen and post-abdomen, forming of them, when thus combined, his Asaphus

Brongniartii; his reason for so doing being also their co-existence in the same rocks.

NUTTAINIA *Hibernica*, (Portlock,) Pl. IV., fig. 1, Pl. V., figs. 1, 2, 3.

CEPHALOTHORAX.—*Glabella* very convex (Pl. V., figs. 1, 3), bending over in front, and exhibiting on the lower surface a slightly grooved margin (fig. 3 b), wide in front, and narrowed posteriorly into a neck by grooves or lines, arched inwards towards the axis. The glabella is, therefore, bounded by one nearly straight line behind, and by three curve lines of nearly equal curvature—one in front, and one on each side—the convexity of the latter being towards the axis. The breadth of the neck behind is about one-third of the chord of the frontal arch.

First Side Lobe.—About three-fourths as wide as the neck; it extends rather more backward than the glabella, but is bounded in front by its side arch.

Second Side Lobe—Extends beyond the first in front, and near its posterior margin exhibits an involuted depression, which may either have been the place of the eyes, or the point of attachment of the antenniform process.

PYGIDIUM, (Pl. IV., fig. 1 c, 1 d.)—The two upper side appendages marked by a linear furrow for one-third of their length, and the last central segment also marked by a similar slightly curved transverse line. The cephalothorax, thorax, and pygidium, covered with granulations or minute tubercles; those on the antenniform process arranged in oblique rows. The lower surface of the cephalothorax of Pl. IV., fig. 1 a, is partly hidden by some other crustacean impressed upon it.

NUTTAINIA? *obscura*, (Portlock,) Pl. XXIV., fig. 4.

The cephalothorax here figured, I refer, with hesitation, to this genus as the nearest to its general form, though its imperfect condition will not allow of certainty. The glabella portion is wide and rounded in front, narrowed and straight behind; width to height or length as ·9″ to ·5″. Near the base there are two obscure tubercles, one on each side of the axis. Of the side lobes, only the first are visible, and they are not so strongly separated from the neck segment as in the preceding species. The surface is finely granular. It is not impossible that the genus Lichas may merge into Amphion.—See Pygidium, Pl. XXIV., fig. 1.)

Genus, ASAPHUS.

Generic characters, as given by Brongniart:—

BODY.—Wide, and tolerably flat; middle lobe salient, and very distinct; flanks, or lateral lobes, twice as wide as the middle lobe; submembranaceous expansions bordering the margin of the lateral lobes; buckler semi-circular, provided with two reticulated oculiform tubercles; abdomen divided into from eight to twelve articulations.

These characters seem insufficient for the correct limitation of a genus, and from their vagueness admit of the collocation, under one name, of bodies exhibiting various forms, and, very frequently, marked differences of structure. Brongniart felt this defect, and in his remarks on Asaphus cornigerus he observes, "this species seems to differ widely from those succeeding it, and to form a particular division by itself; it should singly constitute the genus Asaphus, if later observations prove that the other species may be united either with the Calymenes or the Ogygiæ." This opinion of Brongniart was sound, so far as it pointed to a separation of such very heterogeneous materials; but, as it does not appear possible to unite some of the species, commonly classed with the Asaphs, either with the Calymenes or the Ogygiæ, the generic name Asaphus should be limited to those species which have been most generally recognised as belonging to that genus: a rule which would lead to the opposite of Brongniart's proposition, namely, to the retention of the name Asaphus for those species which he considered might possibly be classed with Calymene and Ogygia, and to the removal of the species, to which he would have limited the name Asaphus, and others similar to them, to the genera Hemicrypturus, Illænus, Isotelus, &c., of more recent writers. It is true that some able observers are averse to many of the subdivisions which have been proposed, but there seems to be no reasonable foundation for their objection. In fossil crustacea the principal organs, on which subdivision in the class is based, are indeed wanting, but if so, there are variations of form sufficiently marked to afford a basis for subdivision: and wherever it is practicable, the establishment of distinct groups is even more desirable in fossil than in recent Natural History, since the accurate determination of species is of far more practical importance in the one than in the other, and as such grouping on satisfactory data, lessens the chance of an evil, even yet existing, namely, the construction of a whole animal from the parts of several; a practice which is greatly encouraged by too widely framed generic characters, as detached parts, agreeing individually with some portion of the description of a genus, may, when found together, be very naturally supposed to belong to the same species. If these reasonings be well founded, it is necessary to modify, very materially, the generic characters of Brongniart, more especially as he takes no notice of the peculiar structure of the lateral costæ, which is common to Asaphus, Calymene, and Ogygia; nor of the great elongation posteriorly of the sides or wings of the buckler, although it enters into the generic characters of Ogygia, and is, moreover, the principal, if not the only distinction between the genera Asaphus and Calymene, when both are subjected to proper limitation. The characters, then, of the genus Asaphus, and of every other genus, should be derived from some tolerably marked natural group; and such appears to be the group formed by A. caudatus, A. tuberculato-caudatus (if a distinct species), A. longi-caudatus, and A. truncato-caudatus (a N.S. described in this monograph). In all these there is a similar structure of buckler, a similar elongation of the side wings, and a similar formation of abdomen and post-abdomen; and they should, therefore, be made the foundation of the genus Asaphus, which would thus correspond in part with Milne Edwards' section "articulated Asaphs."

This view of the subject is certainly different from that taken by Pander (Beiträge Zur Geognosie des Russischen Reiches) who still retains Asaphus cornigerus as the type of the genus Asaphus; but it should be remembered that the genera Illænus and Isotelus have already been recognised by many authors, and, if admitted, must necessarily include within them species so nearly resembling A. cornigerus, that it would be impossible to leave that species either isolated as a solitary representative of the genus, or mixed up with other species in no respects assimilated to it. Moreover, it is in this species, and others closely related to it, that the greatest divergence from some of the characters of Brongniart's genus may be noticed, as the centre lobe is not very prominent, and is even equal in breadth to the side segments, and the eyes are neither distinctly reticulated, nor disposed in a similar manner to those of Asaphus caudatus, &c.

Finally, in reference to this genus, and the same might be said of Calymene, the structure of the lateral segments of the thorax is so different from that of the abdomen, that there can be no difficulty in deciding where the one ends and the other begins; and hence, that Dr. Green and others, who have, in their descriptions, expressed a difficulty in such determination, cannot have had before them specimens in even a tolerably perfect state; assuredly, not in such a state as to be made a foundation for new species.

CALYMENE—(Brongniart).

Body capable of contraction into an almost semi-cylindrical ball. Buckler, with several tubercles or folds, and two reticulated oculiform tubercles; abdomen and post-abdomen having entire margins; the abdomen divided into from twelve to fourteen articulations. No prolonged tail. General form oval. The buckler in front more or less turned up so as to form a raised lip.

Such are the characters assigned by Brongniart to his genus Calymene; and he has himself stated that with the exception of the number of articulations of the abdomen they are vague and unimportant, some of the species of the genus Asaphus graduating by insensible shades of difference into those of Calymene. Nor are they much amended by Dalman who thus characterizes the genus:—

1. Eyes distinct, elevated, situated about the middle of the front.
2. Glabella convex, lobed on each side.
3. Body obovate, contractile into a ball, with numerous segments, from ten to twenty-three.
4. Caudal shield less than the head, with segments either separated or slightly connected together in the form of folds.

Characters which differ from those he assigns to Asaphus only in the articulations of the abdomen, and in the peculiarities of the tail, or post-abdomen, the articulations of which are, in Calymene, stated to be either free or only slightly connected together in the form of folds, and in Asaphus to be merged in a large shield, often similar to the head; a character which, as well as the limited number of articulations of the abdomen, (as has been already shown,) would exclude from the genus Asaphus all those species which are naturally grouped with Asaphus caudatus, and leave within it only those which belong to the new genera, Hemicrypturus, Illænus, and Isotelus; a character, therefore, which cannot be ascribed to the genus Asaphus if founded on the above group. Little remains, then, in the prescribed characters of these genera to distinguish them from each other, whilst into Calymene, as into Asaphus, many species have been admitted which are evidently formed on types differing from those recognised in the characters of the genus; for instance, those species which form a natural group with Calymene macropthalma, have neither the raised frontal lip and margin of C. Blumenbachii, nor the prominent lobes on the sides of the glabella, nor, indeed, the same general construction of head and position of eyes, their whole structure approximating more closely to that of Asaphus caudatus than to that of Calymene Blumenbachii, Calymene macropthalma, like the Asaphs, having, at the posterior angles of its buckler, "pointed appendages prolonged as far as the sixth articulation of the abdomen;" whilst on the other hand, Calymene variolaris possesses neither the prominent tubercles of C. Blumenbachii, nor the plaits, or furrows, of the glabella of Asaphus caudatus. It is then sufficiently evident that much confusion and hesitation, in the identification of species, are the consequences of genera so ill defined and imperfectly limited, and that the attempt to subdivide the old, and more accurately define the new genera, ought rather to be encouraged than discouraged. Pander has done this in respect to Calymene; but not having himself seen any specimens of Calymene Blumenbachii he makes no allusion to it, and consequently it does not appear to which subdivision that species would by him have been referred. His characters of the genus Calymene suit the species he describes, Calymene macropthalma and C. sclerops, which together with C. Downingii, form a natural group closely allied to the Asaphs, yet differing from them in not having the lateral angles of the head or buckler terminated by long pointed appendages.

The preceding remarks on the genera Calymene and Asaphus, were written prior to the receipt of Von Buch's "Beitrage Zur Bestimmung der Gebirgs formationen in Russland." Berlin, 1840. That author cites a work by Emmerich, (De Trilobitis, Berlin, 1839,) in which the propriety of subdividing the genus Calymene of Brongniart has been urged, apparently on the same ground as here maintained, namely, the great difference in the structure of the heads of Calymene Blumenbachii, and of those species which form a group with C. macropthalma, as well as the approximation in characters of the latter to those Asaphs which form a group with Asaphus caudatus, &c. Von Buch further proposes to unite these two groups of Asaphs and Calymenes, into one genus, by the name Phacops, given to the latter by Emmerich. This union was not here originally contemplated, the possession of long spiniform wing-like appendages by the Asaphs, appearing a good generic distinction; as however in other genera, take for example the species which form a group with Asaphus expansus. (Hemicrypturus, Green), Asaphus angustifrons, &c., it seems impossible to make this character generic, some species having a rounded buckler, others an angular one, and others a spiniform one, it cannot be consistently made so in this instance. The genus Phacops will, therefore, include those Asaphs which group with A. caudatus, and those Calymenes which group with C. macropthalma. Von Buch further quotes from Quenstedt (Wiegman's Archives), two valuable remarks, the first, that the number of articulations of the middle lobe and number of the fins (pleuripedes) is definite for each species; the second, that all Trilobites which have large prominent compound eyes with facettes, have eleven articulations of the spindle or axal lobe, and eleven side fins, neither more nor less. This last remark, however, is too general, and apparently founded on limited observations; exclusive of the neck articulation it applies to the genus Phacops, but as that segment is actually a thoracic one, the continuation of the thoracic segments being exposed whenever the buckler crust is broken off, the true number appears to be twelve. In the genus Asaphus (Isotelus the eyes are also compound, see Pl. VII., fig. 4 a, 4 b, although from the delicacy of the facettes they are not so often preserved as in Phacops, and the number of articulations is ten; in the genus Phillipsia (Portlock), the eyes are compound, though from the delicacy of the facettes they often appear smooth, and the segments are nine, or with the neck segment, ten. The genus Phacops, may further be subdivided into two sections, the one having the wings prolonged backwards along the sides of the thorax, and the other having the lateral angles simply rounded. In the first section there is little difficulty in fixing on a distinctive specific character, the varying form of the abdominal margin affording a very good one; in the second section there is considerable difficulty, from which very great confusion has resulted in respect to Calymene macropthalma, the name itself being inappropriate, since all the species of the genus have large eyes. Brongniart figures two species under the same name in his Pl. I., figs. 4 and 5; Murchison notices this and separates them, appropriating, however, the specific name, macrophthalma, to the species which least corresponds with Brongniart's description. Dalman had in some measure done the same, as he cited fig. 5, as C. macrophthalma, and fig. 4, as a variety, adding, however, "distincta videtur species, fronte producta et subnasuta." Pander cites Brongniart, without alluding to the uncertainty of his figures; his own figure would agree best with Brongniart's fig. 4, although he remarks that the head is broader and more rounded in front than in the species C. sclerops," so that, according to him, it may be supposed that both species have projecting fronts, only sclerops in a greater degree than macrophthalma. Von Buch (Beitrage, page 48,) includes under the species Phacops sclerops of Emmerich, or Calymene sclerops of Dalman, Brongniart's Plate I., fig. 4, Pander's Calymene macrophthalma, and Murchison's C. Downingii, and follows Murchison in quoting Brongniart's Plate I., fig. 5, as Phacops macrophthalmus; this, however, is doing some violence to Dalman's original description of the species, sclerops, "caput breviter semilunare valde convexum," and is quite opposed to his closing observation, "a species assuredly so near to C. macrophthalma of authors, that I could almost believe it the same, " obstant vero in descriptionibus auctorum momenta nonulla; e. gr. "*caput antice attenuatum*" quale a Cl. Brongniart in ipsa diagnosi dicitur, quod vero cum nostra specie *minime quadrat*." These extracts and remarks are sufficient to show the almost inextricable confusion into which the species Calymene macropthalma has fallen, a confusion which would have been avoided had Brongniart referred alone to the figure, Pl. I., fig. 4, which most closely agrees with his diagnosis of the species. The simplest method of restoring order is certainly, as was proposed by Green, to restrict the name macrophthalma to the species with advanced front; or perhaps it would be even better to abandon that appellation entirely, as not being exclusively or peculiarly applicable to the species. Before, however, proceeding to the actual description of the Irish species, it is right to observe that the transverse lines or furrows at the base of the glabella, are generic characters in Phacops, being indications of the prolongation of the thoracic segments into the cephalic, or cephalothoracic shield, and therefore ought not to be absent in any of the species, though Murchison describes his C. macrophthalma as not possessing them. The number also, of segments, eleven, in the thorax, exclusive of the neck segment, as noticed by Dalman in his species C. sclerops, is, according to Quendstedt, Emmerich, and Von Buch, constant in all the species, although, when the great difference between the structure of the side members of the thorax and of those of the abdomen is overlooked, some of the latter may be confounded with the former, and the total number in consequence be erroneously augmented.

PHACOPS—(Emmerich).

BODY.—Side lobes almost one-half as wide again as the centre lobe.

CEPHALOTHORAX.—*Glabella*, widest near the front, narrowing to the base; neck furrow strong, showing that the basal segment is distinctly thoracic. Three sets of transverse furrows or lines, the first and second nearly parallel to the neck furrow; the third oblique, inclining forwards, forming the posterior margin of the large frontal segment of the glabella, which is entire and oval, with its longer axis transverse. Bounded by these furrows and by the neck furrow are three cephalothoracic segments, the frontal one being wider at the extremities than in the centre. These segments are united together at the centre with each other and with the front.

Eyes.—Large, compound with facettes, and semi-conical; they are situated in the midst of the cheeks, a portion of which, between the eye and the glabella, appears like a nucleus to the eye, which curves round its internal extremity.

Cheeks.—Marked by a distinct line at the base of the eye, extending outwards to the wings.

Wings.—In one section extended downwards along the thorax in long flattened spiniform appendages, in the other rounded off at the angles so as to form an entire margin to the buckler.

THORAX.—Consisting of eleven segments, or including the neck segment, of twelve. Those of the axal lobe simple, having the ends sometimes so thickened as to look like tubercles, and to appear as abutting points for the side members; when the animal is expanded or stretched out at length, if the external crust of these segments be broken, a subjacent segment is seen which is the front or articulating part of the following segment, see the Amphion Pl. III., fig. 5 b, where it appears as if drawn out on the partial bending of the animal.

Segments of the side lobes compound, Pl. II., fig. 1 c, and not connected together at the extremities.

Pygidium.—Number of segments variable; segments of axal lobe simple; segments of lateral lobes with one furrow down the centre of each. They were all united together by a crust, which, extending beyond the extremities, formed in the long-winged species a wide, in the others a very narrow margin. The point of junction of the thorax and abdomen is easily ascertained, both from the marked difference of structure in their side members, and from a kind of articulating joint between them, the abdomen being terminated upwards by an articulating rounded axal segment fig. 4, and by two semi-side segments. The segments of the abdomen, it may be added, must have been anchylosed together at a very early period; or rather, perhaps, the side members are only to be considered rudimentary, as their number and even their position does not correspond to those of the axal segment.

Phacops, (with the margin of the cephalothorax prolonged backwards in spines).

Phacops *truncato-caudatus*, (Portlock).—Pl. II., fig. 1 a, 2, 3, 4.

Cephalothorax.—Glabella, and in part the cheeks, as well as the segments of thorax and pygidium, granulated; in old individuals the granulations run into each other and become rugæ.

Thorax.—Twelve segments.

Pygidium, fig. 4.—Sixteen distinct, but two more may be counted towards the extremity of the central lobe; side costæ grooved. The marginal crust abruptly truncated at the end, whence the specific name.

This species is one of the most abundant fossils of the schists. Though there is an occasional variation in some of its dimensions, the glabella appearing in some specimens less elongated than in others, all exhibit the peculiar truncation of the abdominal marginal crust, and it may, therefore, be presumed, that there is no greater difference than might be expected to result from difference of sex, difference of age, or even different external condition. According, indeed, to such varying circumstances, the abdomen, more particularly, exhibits considerable variety, appearing broader and flatter as it has undergone more or less vertical pressure; and in like manner the central lobe is more or less prominent, becoming even pyramidal, as it has been subjected to more or less lateral pressure, see figs. 5, 6; and some of the other variations and contortions to which the crust had been subjected, may be traced in the other figures.

The species is distinguished from any other of the natural group with which it is associated by the great conjoint number of its articulations, thoracic and abdominal. The abdominal portion of A. micrurus, as given in Green's casts, if supposed defective, as it certainly appears to be, resembles it; but it would be imprudent to hazard the connexion of a species, so well exhibited as this is, with the doubtful fragments of others, and hence the former allocation of the species to A. astragoletes of Green is abandoned; that with A. Hansmanni is also negatived by the abrupt caudal termination in this species, the margin of A. Hansmanni being quite round. The remarkable projection visible in fig. 1. near the region of the eye, has not been removed, but whether it was actually the side appendage, bent upwards or not, cannot be determined; the structure of the eye is seen fig. 1 d.

Phacops (with entire cephalothoracic margin).

In this section of the genus, there are apparently four Irish species, three in the Silurian rocks of Tyrone, and one in those of Waterford.

Phacops *Brongniartii*, Pl. II., fig. 8 a, b, c, d, Pl. III., fig. 8 d.—Calymene *macrophthalma*—(Brong. Plate I., fig. 4); C. *Downingii*—(Murchison)—and probably C. *sclerops* of Pander.

Cephalothorax.—Margin of glabella contracted in front and slightly raised like a trunk: which being so expressly part of Brongniart's diagnosis of his species, if the name macrophthalma were retained at all this species should possess it.

Pygidium.—Tapering, but not absolutely pointed, Pl. III., fig. 8 a, having about nine distinct central, and six side segments, the latter forked, the forks not of equal length; rounded; the larger fork not quite reaching the margin. The surface of the glabella roughened or granular.

Phacops *Dalmanni*—(Plate II., fig. 7 a, b, c; Pl. III., fig. 7 d.)

The nearest described species is Dalman's Calymene sclerops—(Swedish Trans., 1826. page 232, and C. macropthalma, page 266), which by that author is distinctly stated not to be attenuated in front. His description of the pygidium does not, however, agree with that of the present species, Dalman's C. sclerops having five or six radiating furrows on each side, but only four distinct and four connate articulations in the axal lobe; whereas in this there are nine distinct articulations in the axal lobe, and six side members in each lateral lobe, the number of segments, in the axal lobe, of this and of the preceding species, and of many other Trilobites, exceeding that of the lateral lobes. It is impossible to combine it with Murchison's Calymene macrophthalma, as he represents the glabella to be entire, without cephalothoracic furrows and segments; and Brongniart's C. macrophthalma, fig. 5, being only a side view, does not allow, in that respect, of identification. It appears, therefore, desirable, to give it a name, which should point, as it were, to Dalman's view and name of the species.

CEPHALOTHORAX, *Glabella* rounded in front, the general form of the frontal segment being slightly eccentric or oval, having the larger axis transverse; the eye is less elevated than in the preceding species.

PYGIDIUM.—More rounded than in the preceding species, having nine distinct segments in the axal lobe, and six forked segments in the lateral lobe; the forks nearly flat, not quite equal, the longer not quite reaching the margin; surface of glabella roughened or granular. The lateral members of the pygidium are broader and more flat than in the preceding species.

PHACOPS *Murchisonii*—(Pl. II., fig. 9 a, b; Pl. III., fig. 9 c, d).

This species is well distinguished from the preceding by the longitudinal contraction of the cephalothoracic segments, which gives a shortened aspect to the glabella. From the same cause the base of the glabella appears weakened, as it usually cracks and bends over at that point.

CEPHALOTHORAX, *Glabella;* margin of front slightly advanced; second and third cephalothoracic furrows so near together that the third cephalothoracic segment is towards the axis reduced to a mere line, which foreshortens the base of the glabella.—See comparative figures of the glabellæ of this and the two last species, Plate II., fig. 8 b; Plate III., fig. 7 d, 9 d.

PYGIDIUM.—Tapering but rounded; seven or eight distinct axal segments, and five lateral, which are broad, flat, and furrowed, not reaching quite to the margin. Surface of glabella roughened or granular.

In Plate III., fig. 8 d shows the pygidium of P. Brongniartii, 9 c that of P. Murchisonii, fig. 7 d the cephalothorax of P. Dalmannii, and fig. 9 d that of P. Murchisonii.

PHACOPS *Jamesii.*

This species, from the imperfections of the specimens as yet obtained, cannot be so satisfactorily described as the preceding. It is from impure calcareous beds in the Silurian schists of Tramore, County of Waterford, which having been first noticed as fossiliferous by Lieutenant James, who contributed the specimens, his name has been adopted as specific.

CEPHALOTHORAX.—*Glabella* rounded in front, and, as well as the cheeks, somewhat flattened. Thorax not yet discovered.

PYGIDIUM.—Very much rounded at its extremity; lobes nearly equal to the axal lobe, being broader than in other species; the general form is that observed in the true Calymene. From seven to eight distinct articulations in the axal lobe, and the same number in the lateral lobes, the segments of the latter being broad and furrowed. Glabella roughened or granular.

PHACOPS? *tuberculatus* (CALYMENE *tuberculata*, Murchison)—(Plate II., fig. 10).

All the preceding species have the lobed or divided character of the base of the glabella, which is one of the characteristics of the genus. In Murchison's Calymene macrophthalma, this character becomes obsolete; the neck being shortened to the exclusion of the lobes. This difference would constitute the type of a new group, including Murchison's C. macrophthalma, and C. tuberculata. This latter species appears to be a fossil of the Eifel, unless the one here figured, Plate XI., fig. 10, from specimens contributed by Lord Enniskillen, be a third species. Small tubercles are just visible at the neck.

CALYMENE.

This genus as here restricted, will have the following characters:—CEPHALOTHORAX.—Rounded in front; the horizontal section, therefore, being either semi-circular or semi-oval, divided into three distinct lobes, by two deep furrows, one on each side of the glabella. Margin entire, turning up in front so as to form a channel or groove.

Glabella.—Narrower in front, widening to the base; neck furrow strong; two strong, and one faint, becoming sometimes obsolete, cephalothoracic furrows. The two basal cephalothoracic segments swelling at their extremities into large rounded tubercles, the third merging in the front. Eyes situated near the anterior lateral portion of the cheeks. Lobes nearly equal.

THORAX.—Axal segments simple, with thickened extremities, which almost assume the form of large tubercles, corresponding to the analogous structure which has been noticed in the cephalothoracic segments of the glabella; this structure, in the thoracic axal segments seems connected with the rolling up of the animal; the tubercles on their lateral ends forming a line of flattened balls, the curved surfaces of which admit of an easy and sufficient motion between them, as the line passing through them is changed from a straight to a curved line by the animal rolling itself up. By this contrivance the length of the axal lines on each side would remain unchanged, whilst the length of the central line would be increased by a drawing out of the concealed portion of each segment from beneath the one in front of it, and the external or marginal lines of the sides be reduced to a point or centre by the doubling over of the ends of the pleuripedes, and of their subdivisional segments. The abutment afforded by the balls one against the other, would also give solidity and strength to the animal when thus rolled up. Mr. Murchison remarks, " as the appearance of such tuberculations is most apparent in those specimens which have been coiled up, and *is not visible* in those which are straight and unfolded, may we hazard a conjecture, that the swellings or knots in question are to a great extent the result of torsion and lateral pressure." An examination of the figures (Plate III., fig. 1 a) will show that this conjecture is not strictly correct. *Pleuripedes,* compound or duplex: from the axis to the knee, the two members of which they are composed, form together, as in Phacops, a deep furrow, the frontal member being angular at the knee. the posterior rounded; the furrow shallows towards the extremity where the two members have flattened ends slipping over each other. Number of segments thirteen, or with the neck segment fourteen.

PYGIDIUM.—Small; segments of axal and lateral lobes simple, the latter being furrowed; all the segments united together by an investing crust, which does not exhibit any margin.

CALYMENE *Blumenbachii* is the type of this genus, Pl. III., fig. 1 a.

Dalman justly remarks that there are so many differences both in the descriptions of authors, and in the specimens referred to this species, that it is probable several species are confounded together under the same name—a very natural result of loosely constructed generic characters, which, by admitting under the same generic appellation Trilobites possessed of very different forms of cephalothorax, pygidium, and pleuripedes, have necessarily brought together, as varieties of the same species, those individuals which exhibit somewhat of the same characters of cephalothorax, &c., or, in other words, the same true generic characters. Judging from Brongniart's and Murchison's figures, Pl. III., fig. 1 a, of the Irish Trilobites belongs to this species, and it may be thus characterized, omitting references to generic characters.

Glabella.—The three tubercles on each side of the glabella are in this species distinct, and the form approaches to rectangular.

PYGIDIUM (fig. 1 b.)—Axal segments about seven distinct; lateral do. about four, the latter furrowed.

Mr. Murchison represents the eye line of this species as running transverse, or parallel, to the segments of the thorax, from the posterior edge of the eye to the margin, just as it does in the genus Phacops. Such, however, would be contrary to the true generic distinction (see fig. 2, where that line is seen, as in Dalman's figures, to run obliquely backwards towards the posterior angle of the cheek.) This specimen, being worn, appears smooth. The glabella is imperfect, having been perforated in front by some borer.

Calymene *pulchella*, (Dalman), Pl. III., fig. 2.—This species is separated from the preceding, and referred to Dalman's C. pulchella, which, however, he only proposed as a variety on account of the deficiency of data for separation.

Cephalothorax sub-triangular; *glabella* with two or three tubercles on each side, the front one being nearly rudimentary. This latter character appears to suit fig. 2, where the place of the front tubercle is faintly marked out by a line, the tubercles being merged in the front.

Calymene, *brevi-capitatus*, Pl. III., fig. 3.—In this species the front tubercle of the side of the glabella is entirely lost, and the front itself is very shallow; the glabella, therefore, has only two distinct tubercles on each side, though the third is still, as a rudimentary one, traceable. It is wider than it is long; hence, an appearance of shortness. General form of cephalothorax wide and subtriangular; condition of crust not known, being worn.

It may perhaps appear doubtful whether fig. 1 is really distinct from fig. 2, on account of the imperfection of the specimen; but there can be no doubt as to the distinction between figs. 2 and 3. One of Green's casts of C. Blumenbachii seems to accord better with the form here described; but in another the front tubercles are tolerably distinct. Dalman's C. concinna should be transferred to another genus (see the genus Phillipsia of this work). Brongniart's figures of Calymene Tristani include more than one species; the great differences between them were not unnoticed by Brongniart, but they were explained by him on the principle that such a want of symmetry was due to the peculiar horny or coriaceous nature of the crust, which he supposed capable of extension, contraction, and flexibility, like the coriaceous skin of Holothuria, &c. That the crusts of some Trilobites were possessed of considerable flexibility, is indeed probable, but certainly not to the extent which would be required in order to modify the whole form of buckler and abdomen. Brongniart also remarks respecting the abdomen "the tail is very large, and its lateral parts appear susceptible of great extension," but such a condition appears incompatible with the structure of the abdomen in this and many other genera, in which the side members are united together into one shield or plate by an investing or anchylosing crust. Such an explanation, therefore, of the manifest differences in the several abdomens figured in his Pl. I., fig. 2 b, h, and fig. 2 c, d, cannot be admitted as satisfactory, the abdomens of fig. 2 c, d are small, not large, and if the characteristics drawn from fig. 2 b, h, f, as to buckler and abdomen, be excluded, there would remain little on which a distinction could be founded between fig. 1 and fig. 2 c, as the somewhat more elongated appearance of the latter is the consequence of the animal being more spread out, or expanded, than it is in fig. 1. Fig. 2 h resembles the abdomen of Pander's genus Amphion. Von Buch's reference of Pander's Zethus verrucosus to Calymene Blumenbachii seems very doubtful.

AMPHION.

Pander has separated from the genus Calymene the species C. polytoma, and founded upon it the genus Amphion. His observations as to generic characters are as follow:—Thorax as in Calymene; the deep axal folds are prolonged in the buckler (cephalothorax), being parallel to each other, and extending to the very front of the glabella; the transverse folds of the middle of the head are large. The remaining portion of this paragraph should be specific, namely, as regards the folds of the front of the glabella, which gave rise to the term frontiloba. Cheeks furrowed; very small, flat, lateral eye tubercles; strong neck furrows; side segments of the body very long, without fold, the knee being, on that account, very strongly marked; twenty-four segments in all, the tail consisting of the four lowest; side segments of the tail (pygidium) not connected together, but free at their extremities. Von Buch restores the name Calymene polytoma; but as he does not make any objection to Pander's description, there seems little doubt as to the propriety of retaining the genus Amphion, the great difference in the structure of the pygidium being, of itself, quite sufficient to remove that species from Calymene, and the genus Amphion will, therefore, form, in respect to its pygidium, a link of connexion between the Paradoxides and Calymenes.

ZETHUS.

The genus Zethus, also founded by Pander at the expense of the old genus Calymene, was thus characterized.

Middle body (thorax) as in the genus Calymene (Phacops) and Amphion. The prolongation of the axis folds into the buckler exhibits a medium character between that of Calymene and Amphion, since both converge together, but are not entirely united in front. No trace of eye tubercles; neck furrow very deep; side segments of the body and tail (thorax and pygidium) provided with strong folds, the segments of the latter appearing to be free at their extremities; cheeks without furrows. "We count sixteen segments of the body and tail taken together, as we are not able to separate them properly from each other." The two species which Pander cites as examples of this genus do not agree with each other in what must be considered an essential character, namely the number of cephalothoracic segments: in Zethus uniplicatus there is only one transverse fold, in Z. verrucosus there are three, as in Amphion; or, in other words, one cephalothoracic segment in the one species, and three in the other.

In respect to these genera, there seems some confusion in the description of parts, which embarrasses the comparison of the genera. In Amphion frontiloba, for example, the three furrows in front are represented as belonging to the frontal segment of the glabella; but that such is not the case his Taf. V., fig. 3 a, shows, in which it is evident that the two side furrows separate the true front from the cephalothoracic segments, the centre furrow, line, or notch, alone belonging to the true front. The distinction, then, between Amphion and Zethus would be, according to Pander's description, this—that in Amphion the cephalothoracic segments extend to the very front, ending parallel to the frontal segment; whilst in Zethus the frontal segment is in advance of the cephalothoracic segments, as in Phacops, Calymene, &c.

Pander further remarks that, not having discovered the caudal segment of Zethus verrucosus, he cannot, with certainty, declare that this form really belongs to the genus Zethus. These observations of Pander render it difficult to estimate the validity of his new genus, as the form of the glabella of Z. uniplicatus approximates to that of Phacops, and does not agree with his own characteristics of the genus Zethus. Von Buch cites Zethus uniplicatus as a synonym of Phacops macrophthalmus, Calymene macrophthalma (Brongniart, Pl. I., fig. 5, Murchison, Pl. 14, figs. 2, 4); but though these heads are represented as having only one, or, according to Murchison, no cephalothoracic segment, and should, therefore, be separated from the genus Phacops, they have all prominent eyes, and consequently differ most materially from Zethus, if Pander be correct in supposing his species to want eyes. In defective specimens, however, the eyes may readily be supposed wanting, when they really have not been so. On reviewing the preceding observations, it appears that Amphion frontiloba and Zethus verrucosus differ essentially in two particulars only—first, in the further extension to the front of the cephalothoracic segments of frontiloba; and secondly, in the supposed want of eyes of Z. verrucosus. In respect to the first, the apparent extension forwards of the cephalothoracic segments is merely the result of a diminution of the size of the front, and as that character has not been found repeated in any other species, it can at present be scarcely considered more than a specific distinction: in one even of Dalman's figures the front is actually produced (Plate I., fig. 1 a); and in respect to the second point, as the specimens which Pander has delineated, judging from the drawings, were imperfect, the want of eyes must be considered doubtful: hence, it appears desirable to remodel the characters of Zethus, so as to make the genus more conformable to Zethus uniplicatus and congeneric species with deficient cephalothoracic segments, and to unite Z. verrucosus to the G. Amphion.

AMPHION.

The genus may be thus characterized and distinguished:—CEPHALOTHORAX.—Much broader than high; trilobation strongly marked by the axal furrows, which are deep, and continue nearly parallel to each other from the base to the front. *Glabella.*—Neck furrow deep; three fully developed cephalothoracic segments with rounded ends which do not swell into tubercles, as in Calymene, and are connected together in the centre for about one-third of their whole length; frontal segment rounded in front, and having the transverse oval form of the front of Phacops; the general form of the glabella is rectangular. *Cheeks* large, prominent, but nearly flat on their surface; at the base oblique to the wings, advancing forward from the centre to the sides; they extend as high up as the glabella does. *Eyes* comparatively small in the specimens here described; they were situated at less than one-half of the height of the cheeks, and at one-third of its breadth from the axal furrows; eye lines converging in front, descending with a gentle curve, so as to be nearly vertical, to the eyes, and then curving laterally and downwards to the wings, but not extending to their lateral angle. These two characters are, however, specific, the eyes and eye lines differing, as regards position and direction relatively to the axis, in different species. *Wings* or margin wide, and round at the posterior angles.

THORAX AND PYGIDIUM.—Number of segments according to Pander and Dalman, 24, of which, Pander says, four only are abdominal: this, however, is doubtful (see remarks on the species he described, p. 290), and it is very probable that in this genus, as in Phacops, the number of thoracic segments is constant, and that of the abdomen variable. The *Pleuripedes* are simple, having no groove or fold as in Phacops, &c. The genus, then, differs from Calymene in its cephalothoracic segments, which do not end in large tubercles, and in its front, which is oval, not globular, and from Phacops in the position and arrangement of the eyes, which have no nucleus, as in that genus. It forms, therefore, a transition genus between the two, but differs from both most strongly in the side segments of the pygidium, which are either not connected together, or if that peculiarity be not fully established, are at least totally different in their form and arrangement.

AMPHION *gelasinosus*.—Plate III., fig. 4 a, 4 b.

Height of glabella equal to one-third of the whole breadth of the cephalothorax; its breadth nearly equal to its height; front entire, in height one-third of the distance from the apex to the neck segment; eye line descends to within about one-third of the whole height from the base; surface dimpled. If Zethus verrucosus do, as here suggested, belong to Amphion, it differs from A. gelasinosus in having broader cheeks, and in the eyes (supposing them to exist) being more remote from the axis, as in Amphion frontilobus; and it will be readily seen, on examining that species as figured by Dalman, how easily a specimen, either of it or of a similar species, might be defective, at its extremities, and in consequence not exhibit eyes.

The thorax and pygidium corresponding to this species have not, as yet, been discovered; for remarks, therefore, on the pygidium, see the next species. In fig. 4 a, the front is bent downwards, in fig. 4 b, it is fully extended.

AMPHION *frontilobus*—(Pander).
CALYMENE *polytoma*—(Dalman).

In order to judge of the propriety of referring the next species, of which the pygidium alone has hitherto been procured, to the genus Amphion, a short review must be taken of some of Dalman's remarks on this species, which has become the type of the new genus. Segments of the trunk and pygidium (taken together) 23, or with the small anal plate, 24. The trunk and pygidium so nearly alike that the separation between them cannot be rightly distinguished; axal lobe (rhachis) strongly convex, and narrowing by degrees downwards; ribs more than twice as wide as the rhachis, strongly bent, the segments being narrow or sub-linear; pygidium "laciniis apicalibus inflexis." This description is in strict accordance with the figures given in Dalman's Plate I., fig. 1 b, 1 c; and if the Irish specimen (Pl. III., fig. 6) be carefully compared with Dalman's figure, which is certainly better in some respects than Pander's, many points of resemblance will become apparent, particularly in the compression of the sides and inflection of the side segments round the apex of the pygidium. The difficulty of separating the thorax and pygidium, experienced by Dalman, must be due to an identity of structure in the segments of both parts, or to the absence, at the upper part of the abdomen, of that species of false segment, or joint, which is so manifest in Phacops and Calymene, and either of those peculiarities would be sufficient to confirm the propriety of separating the species from the genus Calymene. In respect to the first, nothing confirmatory, or otherwise, can be stated, from the want of any specimen of a thorax: in respect to the second, in two specimens of the species which it is proposed to annex to the genus, the first lateral segment of the abdomen does not appear as thick as the other segments, and looks very much like the usual articulating segment; as, however, it is rounded like the others, the difference might not be readily visible in the perfect specimen. The furrows between the highly raised and rounded lateral segments, or ribs, being perfectly smooth, renders it doubtful that they were entirely unconnected with each other, especially as the ribs are not tubes, but arches; though, it is probable that the abdomen, from its peculiarly compressed and vaulted form, had considerable flexibility; and this is not an unimportant consideration, as perfectly free lateral segments would connect the genus with genera grouping with Paradoxides, in which the small caudal plate is unconnected with the lateral segments, or with the Cymothoidal section. Calymene punctata, if carefully examined, will be also found to belong to this genus: Pander, indeed, noticing the similarity, was inclined to include it in his genus Zethus.

AMPHION *multi-segmentatus.*—Pygidium, Plate III., fig. 6.

If the comparative view which has been here taken of Dalman's figures of the pygidia of Calymene polytoma and of Calymene punctata, and of the figure here given of the Irish species, has established their identity in general appearance, and in some parts of their structure, it seems necessary to refer the latter to the genus Amphion, founded on the species C. polytoma. Mr. Murchison remarks on the former figure of this species—" The figure of the Ordnance Survey is not unlike C. punctata, though the former has no punctures." Neither of the specimens exhibit such punctures; and in addition, the space between the lateral segments of Calymene punctata is much wider than in the Irish specimens, a peculiarity evident on comparison, not merely with Murchison's, but also with Dalman's figures; our species, therefore, is not Calymene punctata. Dalman does not notice the great number of axal, as compared to the lateral segments: hence, it cannot be C. polytoma.

Characters.—Axal segments very narrow and numerous, twenty-eight being enumerated as far as the last side segments, and still continuing, though very minute, to the very apex. A small lozenge-shaped caudal plate. Side segments twelve on each side, exclusive of the false segment. They are rounded, and slightly bent or raised at their extremities; no punctures or marks of any kind.

I have named this from the peculiarly large number of segments in the abdomen.

Plate III., fig. 6 a.—General view of the abdomen.

Plate III., fig. 6 b.—The apex seen in such a direction as to show the side segments inflected round it.

AMPHION *pseudo-articulatus*—(Portlock)—Pl. III., fig. 5 a, 5 b.

This fine specimen, which points out so clearly the great difference between the genus and Calymene (see especially the pygidia of the two, Plate III., fig. 1 b, and fig. 5 c), was contributed by Lieut. James from Waterford County. It is, unfortunately, not quite perfect.

Glabella (fig. 5 a). Rounded in front, without the longitudinal furrows of A. frontiloba; the side furrows strong, and the lobes resulting from them wide and rounded. THORAX: segments of axal lobe very strongly marked, producing a very striking appearance of articulation; *pleuripedes* strong, simple, and very much flattened in the portions corresponding to the pygidium, in which they are free and imbricated; a flat, broad caudal appendage. Total number of segments not quite certain; probably more than twenty-four. The remaining portions not distinct.

Plate XXIV., fig. 1.—This fine pygidium, with its broad flat costæ, if compared with Plate III., fig. 5 c, is so nearly similar, that it may be assumed as belonging to a large individual of this species, which, if the supposition be correct, must have been more than five inches long. Both these specimens are from Tramore, Waterford, and supplied by Lieutenant James.

Genus ASAPHUS, as restricted.

Proceeding on the principles of subdivision which have been so fully explained, the true Asaphs may be readily distinguished from those species formerly classed with them, but now referred to the more natural genus Phacops. In Asaphus the glabella, though separated at the base from the cheeks so as to form a short neck, blends into one with them in front, so that the cephalothoracic region exhibits an approach to that entire condition which is seen in Isotelus and Illænus. There are no distinct cephalothoracic segments; eyes near the base and axis, having a small peduncular nucleus; eye lines inclining sidewards and upwards from the eyes, so as to produce a form of glabella resembling that of Phacops. Thorax; axal lobe narrow, continued with its segments into the pygidium; pleuripedes twice as long as the segments of the axal lobe, and not continued into the pygidium. They have a central shallow furrow, ending in a fold at the knee, which is strongly bent; number of segments nine.

ASAPHUS *latifrons*—(Portlock)—Pl. VII., fig. 5, 6.

This species approaches nearest to Dalman's A. angustifrons, from which, however, it differs by the direction of the eye lines; in Dalman's species they converge in front to a central point, producing a narrowed form of glabella; in this, with a sharp curve near the lateral margin, they end at about one-half its height, producing a broad front. General outline oval; length, 1·25; breadth, ·62, the breadth of the cephalothorax at its base ·69; cephalothorax and pygidium of equal length, being more than one-third of the whole length ; cephalothorax ending at its posterior angles in slightly produced points. Pygidium ; marginal depression nearly one-eighth of an inch wide : in front there is one very distinct lateral furrow, forming a well-marked fold, or pseudo-segment.

ASAPHUS *marginatus*—(Portlock)—Pl. VII., fig. 7.

This is an obscure species, the specimen being bent, and the cephalothorax either disturbed or imperfect, as the position of the eyes cannot be determined : it is probable, however, that they were small, very close to the axis, and near the neck. The axal lobe is narrow, and the lateral lobes wide, the knee being strongly marked. The pygidium is the most distinct portion of the specimen : it is twice as wide as long : length ·5″, breadth ·1″, the marginal portions being deep, ·16″ wide, and strongly marked anteriorly by an angular edge. As the margin occupies so large a portion of the pygidium, the name marginatus has been applied to the species. No markings appear on the axal lobe ; but it may be remarked on this, as well as on other species, that an internal cast, divested of the crust, cannot be expected to exhibit all the markings or parts of that crust. There is a similarity of structure between this species and Murchison's Illænus perovalis, which makes it probable that they will hereafter be grouped together in a new genus.

ASAPHUS *dilatatus*—(Dalman)—Pl. XXIV., fig. 2.

This curious pygidium is not anteriorly quite perfect, as there was at least one more original segment than is represented in the figure. The axal lobe is broad, and had at least seven segments ; the lateral costæ are only marked out by furrows or plaits which do not extend to the outer rim. The whole pygidium is very much flattened, and marked by fine vein-like lines, as in A. Buchii, &c. The axal lobe is wider than in Dalman's figure, and not so tapering ; but these differences may depend either on defects in drawing, or on a difference in the condition of the specimens. Newtown Head, Waterford, communicated by Major Austin ; coarse schists, remarkably similar to those of Tyrone.

ISOTELUS—(Dekay), 1824.

BODY.—Oval, oblong, often contracted, not unfrequently extended.

HEAD, or Buckler (cephalothorax.)—Large and rounded, equalling the tail in size with two oculiform tubercles.

ABDOMEN (thorax.)—With eight articulations.

POST-ABDOMEN, or Tail (pygidium.)—Broad, expanded, with indistinct divisions, as large as the buckler ; longitudinal lobes very distinct.

Dekay appends to these characters the following additional remarks :

"Frontal process beneath, with two semi-lunar terminations, a character which, from Pander's observations, is probably common to more than one genus. It is distinguished from Calymene by the presence of but two tubercles on the buckler, which are not reticulated, and by the abdomen with but eight articulations." Here Dekay confounds together parts totally distinct in position and function, the axal tubercles of the cephalothorax of Calymene having no analogy or connection with its oculiform tubercles. It should rather have been said that the true genera Asaphus, Isotelus, and Illænus, are distinguished from Phacops and Calymene by the absence of cephalothoracic segments—by a diminished number and by a different structure of the thoracic segments, and by a lesser development of the pygidial segments. It is unnecessary to cite Dekay's further distinctive remarks, as they do not bear sufficiently on important or certain characters—the non-reticulation of the eyes, for example, being by no means established as an original condition. From the genus Asaphus as restricted, Isotelus is separated by characters which, though striking as regards the general aspect of the animal, are not in themselves of much weight; for example, the great width of the axal lobe, which influences so much the appearance of the animal. In the fold on the pleuripedes, and the direction of the course of the eye lines, it resembles closely Asaphus.

The number of thoracic segments (eight), and the total disappearance of segments in the axal lobe of the abdomen, are characteristic of the genus.

Dekay described two species—Isotelus planus and Isotelus gigas—which are, however, so nearly related to each other, that he surmised the possibility of I. planus being the young of I. gigas, though Green asserts that there is a considerable difference in the proportion of their parts. In truth, the difficulty of deciding on species in this genus is more than usually great—slight variations in the position of the eyes, and in the form of the pygidium, being the only tangible characters. Green enumerates five species, of which one, at least, I. stegops, is founded on fragments too imperfect for specific discrimination. The depth of the lateral lobes, as stated by Green in I. planus, three-tenths of an inch, seems quite insufficient to distinguish that species from I. gigas: indeed, judging from the casts, the depth in I. gigas (cast 21), is proportionally quite as great as in I. planus (cast 23); the latter cast is, however, very imperfect. Dekay, in describing I. gigas, states the breadth of the axal lobe to be twice that of the lateral lobes. This, however, can only apply to the portion of the lateral lobe extending from the axis to the knee, as the total breadth of the lateral lobe is equal to two-thirds of that of the central lobe; the knee is strongly marked in the genus. There is one deep lateral furrow at the upper part of the pygidium, but no regular segments, either axal or lateral.

Isotelus *gigas*—(Dekay)—Pl. VII., fig. 1.

The large pygidium here figured closely resembles Green's cast 22 in appearance and proportions. Length, 3·5 inches; breadth, 4·4″, or as 28 to 35; the form is tapering, and when *decorticated*, so as to show the marginal depression, appears more so; the axal lobe is visible; converging striæ on the marginal depression when exposed; this animal, if perfect, would have been about nine inches long.

Isotelus *gigas*—(*planus*, Dekay)—Plate VII., fig. 2, 3.

Length, 3·12 inches; breadth, 1·62, or as 25 to 13; the general form is oval; the form of the pygidium more rounded and less tapering than in the preceding species, which, indeed, is almost the only, and it is a slight, difference between them; hence, notwithstanding the slight variation in form it is most probable that this is the young of I. gigas, as conjectured by Dekay. In fig. 2, part of the crust being removed from the cheeks, the sides are seen to be quite steep, and at the edge or base, exposed by the removal of this covering, there is a projection facing upwards, longitudinal in direction, and having very much the appearance of an articulating process. This is seen better in Plate VIII., fig. 2, which is the lower surface; and in Plate VIII., fig. 7. Pander has already conjectured, as before cited, the possibility of a vertical movement, and possible separation of the portion extending to the eye lines, from the portion within them, &c.; this peculiarity of structure lends some support to that opinion. In Plate VIII., fig. 3, the cephalothorax is looked into from below: the lower or articulating member though broken, being seen in its proper place. In Plate VII., fig. 3, Plate VIII., fig. 1, the internal pronged appendage, first noticed by Dekay and Stokes, but more elaborately discussed by Pander, is seen in its proper place; it is called here internal, because, judging from the depth of the cephalothoracic region it is certainly not even with its lower surface; whilst the section of the prongs being triangular, with the vertical angle or edge downwards, renders it also improbable that they were level with the lower surface, as they would then have appeared like projecting and uneven ridges. Pander states the difficulty of chiselling out these parts, so as to show their true connexion and object. Of the member delineated, Plate VIII., fig. 2, 3, Pander succeeded in showing only the frontal part, but not the prolonged side extensions with their articulating tubercle, or process. With the forked appendage he was more successful, and he figures several differing in form according to differences of genera. Many of these bodies have been found; two of which of large size (probably from large individuals of Isotelus gigas), are figured, Plate VIII., figs. 4 a, 4 b, and show that they are not such simple bodies as they at first appear. Looking at their upper surface, or that seen by removing the upper crust, as in fig. 1, or in Plate VII., fig. 3, it is nearly flat, and marked by striæ. In front it is bounded by a nearly straight line bending downwards, at its extremities, which corresponds to a similar bend in the central portion of fig. 2; from the extremities the outline turns sharply inwards, so as to render the ends angular wings; then turns outwards, and again, with a second and regular curve, bends inwards to the points of the forks. The breadth at top is about equal to the total length; and the distance between the points of the fork is about two-thirds of the total breadth; at the curved top of the space between the forks there is a deep furrow or cavity, and the solid matter of the forks is easily removed, when, as in fig. 4 b, they appear to have occupied deep triangular spaces which are separated at the top from the upper portion by a bent line or joint, so that this remarkable body, which appears on its upper surface entire, is divided on its under surface into two parts. Two ideas naturally suggest themselves in respect to this structure: either that this bent line was a line of articulation, the posterior portion comprising the forks being moveable on the anterior portion, though connected with it by a flexible crust forming the upper or internal surface, (and it should be here remarked that Pander conjectures that these bodies may even be the more fixed parts of the conjoint organs of motion and respiration, not having, as it were, dissected them so as to show their compound character); or secondly, it may be supposed that the anterior portion at top and the forks below were fixed, and that the lower edge of the anterior portion was moveable, meeting the forks at the bent line of junction. If this be the case, may it not be possible that the true opening into the stomach was at this bent line, and in fact that there is here a buccal apparatus fitted to crush the food of the animal? Pander represents the flat surface of these bodies as being below; but if the parts are in their right places, as shown in Plate VII., fig. 3, Plate VIII., fig. 1, such cannot be the case. Whether the movement of the parts of these buccal bodies is further connected with the apparently maxillary articulation, fig. 2, there are not at present sufficient data to determine. The depth of the section of the triangular fork is about one-half of its width or base. In fig. 1, the upper crust of the cephalothorax having been removed, the lower crust is seen from above; it is divided in the middle, which has induced Pander to conjecture a power of separation in a lateral direction. In fig. 3, the lower crust, as seen from below, is entire, a difference which either may, as Pander supposes, be due to generic differences; or it may be possible that, whilst externally it is entire, internally it is divided. In Plate VII., fig. 4, the true nature of the eyes is manifest, as the reticulation, though extremely fine, can be distinctly discerned on part of the surface. Plate VIII., fig. 6, shows the imbricated pleuripedes from a large individual.

ISOTELUS *ovatus*—(Portlock)—Plate VIII., fig. 5.

This appears to approach closely to a young individual of Green's species, I. Cyclops, which he describes as having the head more elongated than the preceding species, the anterior portion of the buckler being much prolonged; the eyes approximate, rounded, and near the posterior edge of the head; the middle lobe of the thorax scarcely broader than the lateral lobes; pygidium rather broader than the cephalothorax, and ovate, posterior termination more rounded than the buckler.

Green's cast, No. 24, does not support the term "approximate eyes," as they are distant from each other nearly the width of the axal lobe; nor can the posterior termination be called more rounded than the buckler. Whether the eyes were originally so fully rounded may also be doubted. In the Irish specimen the cephalothorax is more elongated than in I. gigas, exceeding the length of the thorax, the proportions of cephalothorax, thorax, and abdomen being 18, 17, 16. The total length is 1·25 inch. Total breadth ·8 inch. The axal lobe is a little wider than the total breadth of the lateral lobes. The cephalothorax is rounded in front, as is the abdomen behind. The eyes are rather less than one-half of the height of the cephalothorax from its base; they are situated on the prolongation of the axal lines; scarcely a trace of the axal lobe in the pygidium. The general form is a regular elongated oval. By the lengthened cephalothorax it approaches I. Cyclops, and differs from I. gigas, whilst the position of the eyes separates it from I. Cyclops.

ISOTELUS *Powisii*—(Murchison)—Plate VI., fig. 1.

Oval; broad and flat; more rounded posteriorly than in front; length of cephalothorax 1·5 inch, of thorax 1·5 inch, of abdomen 1·75 inch; total length being about 4·75 inch; breadth 2·8 inch; eye lines terminate near the sides; eyes are situated at less than one-half the height of the cephalothorax. This species differs considerably from the preceding, being much more flattened, which is due to the bend or knee of the pleuripedes, occurring nearer to the sides. The segments are broad and the fold is strong. This is referred to Murchison's Asaphus Powisii (Silurian system, Plate 23, fig. 9), as the thorax and abdominal portion there figured strongly resemble those of the present species. The head, however, supposed to belong to them, is most probably of a different genus. In Murchison's figure the abdominal margin is partly decorticated, so as to show the striæ.

Fig. 2, is intermediate in form, between the pygidia of I. gigas and I. Powisii; it must have belonged to an individual six inches long.

ISOTELUS *rectifrons*—(Portlock)—Plate IX., figs. 1 a, 1 b.

These cannot with certainty be ascribed to this genus. 1 a, is the glabella of one specimen found isolated, and 1 b, is a portion of the glabella of another, together with the cheeks of one side, showing the ease with which those parts could be separated. The eye lines extend laterally only a short distance, and the eyes curve round a swelling nucleus or projection of the glabella; they are very near the posterior margin of the cephalothorax and widely separated from each other. The nearest described form of cephalothorax is Asaphus tyrannus, var. ornatus, of Murchison (Silurian system, Plate 24), which exhibits the same overlapping of the cheeks, the same form of eye, and the same short prolongation sidewards of the eye lines. That the figures 1 a, 1 b, of Plate 25 of the same work are identical with Plate 24, or indeed with themselves seems improbable, when their form and structure are carefully compared. Asaphus Buchii, Plate 25, fig. 2, exhibits much similarity of cephalothorax, has, as well as A. tyrannus, Plate 24, eight thoracic segments, but comparatively a narrow axal lobe. Those species, therefore, whilst they approximate in some respects to Isotelus, differ from that genus in the position of the nucleus of the eye, in the greater space occupied by the cheeks, and in the structure of the abdomen; whilst in like manner they differ from the species of Asaphus, hitherto described, by the full development of the lateral segments of the abdomen. It is probable, therefore, that a new genus should be formed, inosculating with Isotelus and Asaphus, but the data for its construction are at present incomplete. The species here figured differs from Asaphus tyrannus, Plate 24, of Murchison, in the very backward position of the eyes. The reticulation of the surface of the eyes is not visible in 1 b; but this does not prove that they were not reticulated. As the great breadth of the glabella corresponds to a wide axal lobe, the species for the present will be left in the genus Isotelus; and from the peculiar straight outline of the front, will be called Isotelus rectifrons.

ISOTELUS *arcuatus*—(Portlock)—Plate IX., figs. 2, 3.

These specimens of pygidia are referred to the genus Isotelus, from their general resemblance to that member of other species of the genus. The proportional length to breadth is less than in any known species, being in the three specimens—1–1·78, 1–2·00, 1–1·90; whilst the peculiar arched form posteriorly is equally characteristic, and hence the name; all three specimens are in part decorticated and show the usual striæ.

Isotelus *læviceps*.—Plate IX., fig. 4 a, 4 b.—Asaphus *læviceps*—(Dalman).

These do not appear identical with any of the preceding, the glabella being much more strongly separated from the cheeks by a deeper furrow than in the typical Isoteli, whilst the eye lines extend laterally to only about half the breadth of the cheeks; the general form, however, is similar to that of I. Powisii, but more rounded; and it so closely approximates to the form of Dalman's species, that it may at least provisionally be referred to it. Fig. 4 b, is contorted, and it shows the small maxillary (?) tubercle at the posterior angle on the right side. The pygidium of Dalman's figure exhibits neither axal nor lateral segments, and is therefore classed with the Isoteli; the glabella is not sufficiently prominent to be classed with Asaphus palpebrosus.

Plate VIII., fig. 6.—Segments of Isotelus gigas, (?) displaying the manner in which they lap over each other, which being so much more than could be expected in the mere movements of segments of an ordinary crustacean, supports the idea of their functions as locomotive organs.

Isotelus *intermedius*—(Portlock)—Plate IX., fig. 5.

This specimen is partly rolled up, and is not sufficiently preserved for accurate specific description. The axal lobe is wider than it is in I. Powisii, the lateral lobes being little more than half the width of the axal. The eyes appear to have been nearer the axis and nearer the base than in I. Powisii. The pygidium, fig. 5 b, rounded, and shorter than in I. ovatus; but, like it, without any sensible rise of the axal lobe. I only separate it provisionally, as the specimen obtained by Lieut. James, at Tramore, is insufficient to decide its claims to rank as a distinct species, though it certainly differs, in the particulars noted, from the preceding.

Isotelus *sclerops ?*—(Green)—Pl. X., figs. 1, 2.

These specimens appear to belong to Green's Isotelus sclerops, the cephalothorax being very sharp, as also the glabella, the eye lines meeting in front at an obtuse angle. The large specimen must have belonged to an individual eight inches long, so that the species, if really distinct from I. gigas, was also a very large one.

Illænus—(Dalman).

Head.—Very wide, convex, rounded in front, with the sides deflected.

Eyes.—Lateral, widely separated, and on the temples. Trunk, with nine or ten smooth segments, that is, having the two ordinary longitudinal furrows, but no transverse groves or furrows.

PYGIDIUM.—Very large, entire, smooth. Between the segments of the thorax, there is a narrow fillet or intermediate segment.

Dalman divides the genus into two sections, the one having the posterior angles of the cephalothorax prolonged, the other having them rounded.

The genus approximates closely to Isotelus; but is distinctly separated by the structure of the pleuripedes, which have no fold, and are either rounded or flat; the eyes also are very differently situated, in the one approximating to the glabella, in the other being widely removed from it; the number of segments is likewise greater than in Isotelus.

ILLÆNUS *centrotus*—(Dalman)—Plate X., figs. 3 a, 3 b, 4, 5, 6.

Although the wings of the cephalothorax have not been found with any of the specimens here figured, there can be little doubt of the identity of the species with that of Dalman. His description is as follows, and will be contrasted, in a running commentary, with the Irish specimens.

BODY.—" Short, with nine articulations, segments smooth; axal lobe convex, rather wide, yet narrower than the ribs, which are strongly bent."

The thorax is extremely short in this species, as is evident from Dalman's figure, as well as from the figures here given both of young and old individuals; it is, indeed, considerably shorter than either the cephalothorax or the pygidium, and therefore becomes highly characteristic of the species. The segments are, in consequence, very narrow and weak. If the side segments were stretched out, they would equal, if not exceed in length, the axal segment; they are smooth, and slightly rounded.

HEAD.—" Large, semi-lunar, convex, very smooth, with the posterior angles extended into sharp horns not reaching the base of the pygidium; at the base of the head two obsolete longitudinal impressions shorter than in A. crassicauda." In the large specimen (fig. 3 a), the head (cephalothorax,) is imperfect, part of it being doubled over; restoring it, however, as well as possible, as is done in fig. 3 b, it is seen to be very large, and has a striking resemblance to Dalman's figure. The head of fig. 5 shows the very short prolongations of the axal furrows.

PYGIDIUM.—" Large, semi-orbicular, less convex than in I. crassicauda; very smooth. The rudiment of an axal lobe, conoid, scarcely convex, obsolete, and not distinguished by any marked impression from the disc of the pygidium."

The pygidium is in all the specimens large, semi-orbicular, convex, and smooth; it was probably covered with a very thin uniform crust, corresponding to its other character of weakness, as fig. 4 exhibits numerous cracks on its surface; some slight indications of an axal lobe are seen in the younger individuals, but are totally lost in the larger or older; when decorticated the usual striæ are seen on the margin. The length of the young individuals is about ·7″, and their breadth about ·4″. The length of the larger, fig. 3, could not be less than 3·4″, and its breadth 1·6″, and the body itself (thorax), is only ·7″ long. Dalman's specimen was intermediate in size which accounts for the greater development of the axal lobe in its pygidium, than in the specimens, figs. 3, 4. Looking at all the figures it is very interesting to observe the growth, from infancy to age, of individuals of this species in the same locality.

ILLÆNUS *crassicauda*—(Dalman)—Plate X., figs. 7, 8, 9.
ENTOMOSTRACITES *crassicauda*—(Wahlenberg).

Dalman's description:—" Body with ten segments; head very large, semi-circular, gibbous; facial line, with a very wide frontal arch, short and nearly straight behind; eyes small, situated on the temples; ribs at the sides sharply bent."

In this species the axal lobe gradually diminishes towards the abdomen, into which the axal furrows are distinctly prolonged; the length of the thorax (fig. 7,) is equal to that of the pygidium; Dalman represents it as greater, and in the younger specimen, fig. 8, it is so. The cephalothorax of fig. 7, is deficient, and that of fig. 8 is bent over and broken; but if restored, as well as possible, it would appear to have been large. This latter figure strikingly resembles Wahlenberg's figure (Tab. II., fig. 5), which seems to have been also drawn from a young individual with its head similarly bent over. The pleuripedes are nearly flat and bent almost at a right angle, at one-half their length from the axis. The abdomen when decorticated exhibits the usual striæ, which are rather coarse. The total length of fig. 7, was about 2·5 inches, its total breadth 1·7 inch. The length of the young individual, fig. 8, ·9 inch. Figs. 9 a, and 9 b, represent an imperfect and rolled up specimen, furnished by Lieut. James, from Tramore, County of Waterford. It has the general character of the species, though the axal lobe is somewhat wider at the base of the abdomen than in the preceding figures; the data are not sufficient for separation, and it remains, therefore, associated with I. crassicauda.

Plate XXIV., fig. 6.—The glabella here figured probably belongs to this genus; it is remarkable for a slight central ridge or keel.

Species incertæ sedis.

The following are distinct from any of those previously described; but from the imperfection of the specimens cannot be allocated to genera with absolute certainty.

Illænus *quadrato-caudatus*—(Portlock)—Plate XXIV., fig. 2.

The specimen is scarcely sufficient to determine whether there actually is trilobation; however, as the ends of the ribs are not deflected it is probable that there is, and the specimen is therefore referred to Illænus: the remarkably straight sides of the pygidium give it a squared appearance, whence its name.

Ogygia—(Brongniart).

The characters assigned to this genus by its founder are obscure. In the descriptive remarks, however, something more distinctive may be traced out, particularly as regards the post-abdomen (pygidium). "Its lateral parts appear to have been much less scaly and consequently more membranaceous than the lateral parts of the abdomen;"—and Bronn observes, "the segments of the tail (pygidium.) are united together into a large somewhat sharp-pointed shield or plate, the axis of which does not extend to the end." It would appear from these observations that Ogygia, in respect to its pygidium, is distinguished from Paradoxides and possibly from Amphion, by the union of its axal and lateral segments into a caudal shield: from Brontes, by the great prolongation of the axal lobe into it: from Amphion, also, by its evidently membranaceous character.

Ogygia (?) *rugosa*—(Portlock)—Plate V., fig. 10.

This is only a fragment, but if complete, would evidently possess the sharp-pointed termination of the genus. The axal lobe is divided into a great number of very thin (ring-like) segments. The sides appear to be entire, though strengthened by narrow ribs with thickened ends, all inclining backwards; the surface between the ribs is roughened with irregular dots, giving the whole a rugose appearance.

Locality—Tyrone, Desertcreat; lower portion of Silurian schists.

In the preceding pages fifty-two species and varieties of Trilobites have now been described or noticed; and even allowing for the unavoidable uncertainty which must sometimes attend on specific discrimination, this is a large number compared to the limited geographical range of the district in which they occur. It remains now to test their value, in estimating the differences of geological formation, and in doing so, to adhere to the sound principle that in the district itself the data should be found for its own separation into parts. The comparison of the data of one country with those of another is essential for the general allocation of such parts to their right places, and will often clear up difficulties or remove obscurities, which even the apparent order of superposition could not dispel; but in the strata themselves should be sought the evidence, which is to prove that they are the same as, or in a geological sense, different from each other. The Trilobites hitherto described have all been those which in other formations have characterized the lowest fossiliferous strata; it is now to be inquired what position they occupy in this. In the beginning of the chapter, the coarse arenaceous schists containing Trilobites in such great variety, have been shown to skirt and rest upon granitic and hornblendic rocks, and to be succeeded by a considerable extent of sandstones and conglomerates, and then by shales, sandstones, and limestones, constituting the great Carboniferous system. In the shales associated with the lower sandstones other Crustacea, not of the family of Trilobites, occur; thus, in the parish of Maghera, County of Derry, the genus Limulus occurs; and in Tyrone a new species of the remarkable genus Dithyrocaris, first noticed by Dr. Scouler in the carboniferous limestone of the neighbourhood of Paisley, in Scotland. The genus Cypris is also met with, and extends up into the shales distinctly associated with the carboniferous limestone; these latter shales contain also Trilobites, but as they are generally fragments, principally of pygidia, it may be reasonably assumed that they have been much moved about before being enveloped in the mud or shale now containing them. In the limestone they are occasionally found perfect; it is easy, therefore, to decide how far they correspond with or differ from those of the more ancient rocks; and it may be stated with confidence that, in the present state of knowledge, the Trilobites of the older and newer strata of the district here described, differ not merely specifically but also generically. To decide how far this deduction may be extended over a wider space than the district itself, is difficult, both on account of the uncertainty of geological determinations and the imperfection of many of the descriptions of fossils ; it is, however, valuable to trace out such marks of distinction in even a limited district, as they may lead to the correction of errors in others. The genus to which a considerable portion of the mountain limestone Trilobites closely approximates, was established by Steininger for a Trilobite of the Eifel ; its true type, however, appears to be Dalman's Calymene concinna, a species found in Gothland, in 1835, by Gabriel Marklin, and communicated by him to Dalman. The characters assigned to the genus by Steininger are imperfect, and require to be conjoined with some of those given as specific by Dalman :—

PROETUS—(Steininger).

" Corpus sub-ellipticum, contractile ; caput scutatum ; oculis duobus lateralibus, simplicibus ; trunci segmentis decem ; scuto caudali rotundato."

In this meagre generic description, the simple eyes, and the number (ten) of thoracic segments are the only tangible characters ; and of these one, namely, the simple eyes, is doubtful, as very delicate reticulation is discernible in the allied species of the mountain limestone, whilst the other is not peculiar to the genus.

Dalman characterizes his Calymene concinna thus :—" Capite semilunato, margine antico incrassato ; glabella convexa integra, pone oculos transversim impressa et utrinque tuberculo aucta ; trunco segmentis decem ; pygidio semi-orbiculato." He further adds, " Head almost semi-lunar, the margin much thickened and separated from the front and cheeks by an impressed line. Glabella sub-ovate, convex, smooth, with no lateral lobes, but with a transverse impression behind, thickened vertical margin, provided on each side with a tubercle and in the centre with an elevated point. Axal lobe of trunk (thorax) very convex : ribs deflected at the points ; lateral lobes not twice as wide as the axal. Pygidium semi-orbicular, with a deflected margin ; axal lobe continued through three-fourths of its length, very convex with one or two strongly marked segments, the rest being fused together, the sides obscurely marked by numerous radiating striæ, so that the lateral margin when magnified appears sub-imbricated. Steininger notes as peculiarities by which his species (Proetus Cuvieri) may be distinguished from Dalman's,—1st. " The absence of the annular border at the back of the cephalothoracic buckler," which is probably a mistake, as on comparing together Dalman's figs., 5 a, 5 b, the latter a profile, it will be seen that the transverse impression is in fact the neck furrow, and that the neck segment or "annular border," corresponds in the profile with the thickened cephalic margin, although, by mistake, it does not in fig. 5 a. That this is the nature of the mistake is further seen by the position of the elevated central point, which in fig. 5 a is not represented on the annular border as it should have been, but on a segment below it. If this mistake be rectified, there is no other general difference in the structure of the cephalothorax of the two species; and the specific difference in Steininger's species is, as respects the cephalothorax, the want of the side tubercles on the neck segment.

2nd. The width of the axal lobe of the thorax greatly exceeds that of the lateral lobes, which is the reverse of Dalman's proportions.

3rd. The front being nearly as wide as long, is proportionably wider than in C. concinna.

4th. The post-abdomen is a little longer than one-half of the buckler. The flanks, almost smooth, surround the projecting middle lobe, terminating posteriorly with a flattened border as in C. concinna. The middle lobe exhibits seven impressions in the form of segments.

These observations of Dalman and Steininger have been quoted in order to place in a prominent point of view the reasons for not including the mountain limestone species in the genus Proetus, and for forming them into a new genus, which may be considered to represent, in the Carboniferous system, the genus Calymene of the Silurian.

PHILLIPSIA—(Portlock).

General form, oval.

CEPHALOTHORAX, divided into three compartments by the elevation of the glabella above the plane of the cheeks. *Glabella*, bounded on the sides by nearly parallel lines, and rounded in front; the general form approaching to cylindrical; marked on the sides by three sets of segmental lines, corresponding to and representing the cephalothoracic furrows of Phacops and Calymene, but which are not present in Proetus. The first, from the base, of these lines is rounded, so as to include a circular space corresponding to the tubercle of the lower cephalothoracic segment of Calymene; the second is also slightly curved; the third nearly straight. Between the two sets of lines there is a space equal to more than one-third of the whole breadth of the glabella, corresponding to the similar axal or connecting space in the glabella of Phacops and Calymene. The *Cheeks*, slightly convex; in form spherical triangles. *Eyes*, lunate; situated on the cheeks, but very near to the glabella, to the axis of which their chord or longer axis is parallel; surface under a magnifier very finely reticulated. Neck furrow, deep. *Wings*, or margin, are separated from the front and cheeks, by an imperfect line or furrow which is connected with the neck furrow, and end posteriorly in sharp angles more or less prolonged as spines. The margin is turned down, and forms, on the under surface, a narrow striated rim.

THORAX composed of nine segments, or, including the neck segment, ten; and it requires some care to avoid mistaking the first pygidial for the last thoracic segment as it is constructed on the same principle as those of the thorax, though its parts are fused together and form one whole with the other pygidial segments. The *Pleuripedes* are compound as in Phacops, Calymene, &c.

PYGIDIUM exhibiting, both in the axal and lateral lobes, distinct segments by which it is further separated from Proetus. The axal lobe and the lateral segments do not extend to the external edge, but have a considerable marginal space. It may be here remarked that as this form of pygidium recurs in another mountain limestone genus, although the corresponding forms of cephalothorax are strikingly different, the genus cannot be satisfactorily determined from a specimen of the pygidium alone.

Professor Phillips (Geology of Yorkshire,) has described eight species of Trilobites, all of which he includes provisionally in the genus Asaphus. The genera of two of these species, Asaphus granuliferus, Pl. XXII., fig. 7, and Asaphus gemmuliferus, Pl. XXII., fig. 11, cannot be determined, with certainty, from the figures which represent pygidia only. Of the other species, Asaphus seminiferus, Pl. XXII., figs. 8, 9, 10, Asaphus truncatulus, Pl. XXII., figs. 12, 13, and probably Asaphus obsoletus, in part, Plate XXII., figs. 3, 5, belong to the present genus. On comparing Phillips fig. 12, with Pl. XII., fig. 1 b, of this work, a striking general resemblance will be perceived; he, however, represents the glabella as quadrisulcate, whereas the number of sulci in the Irish specimens is only three, a number consistent with the view here taken of the genus. The posterior angles also of the cephalothorax of Professor Phillips' figure do not project backwards so far as in the Irish species; these two points of difference may, however, be the result of some slight imperfections in Professor Phillips' specimens. The head (fig. 12,) does not, of course, belong to the same individual as the abdomen (fig. 13). Between fig. 13, and the magnified representation fig. 1 c, (of the pygidium of fig. 1 a,) a similar resemblance is evident; in fig. 1 c, however, the margin (limb of Phillips) is not striated; but it may be presumed, from the remarks already made on the striæ of the pygidia of Trilobites, that there is this difference, simply because, in one case the natural cast exhibits the external, in the other the internal surface; as, however, the term *truncatulus* seems to have no peculiar reference to this species, it will be named after the gentleman, Mr. Kelly, who supplied the beautiful specimen here figured. Mr. Kelly is employed in the preliminary Boundary Department of the Ordnance Survey, and has been a most zealous and effective assistant to Mr. Griffith, in his geological inquiries.

PHILLIPSIA *Kellii.*—Plate XI., figs. 1 a, 1 b, 1 c, 1 d, 1 e.

Elongated oval; length ·9″, breadth ·5″ nearly.

CEPHALOTHORAX elevated, bounded by a flattened margin, or wings, which extend at the posterior angles into spines, as far as the fifth thoracic segment. *Glabella* convex, elongated, even in front with the cheeks, but not extending to the edge of the margin; rounded in front; at the sides bounded by lines nearly parallel, yet with a slight curvature inwards. Breadth, equal to about one-third of the total breadth of cephalothorax; the third, or anterior, cephalothoracic furrow very faint; *cheeks* large, and the eyes being comparatively small, there is a large clear space; *eyes* do not reach the neck furrow behind, nor extend beyond the third furrow in front; neck furrow deep.

THORAX.—Axal lobe about equal to lateral lobes in breadth; axal segments (fig. 1 d) not marked by tubercles, which are arranged, however, along the arched division of each pleuripes, not along the angular division, and continue up to the knee, or bend of the segment, which is strongly marked.

PYGIDIUM, rather wider than long, about fifteen axal and thirteen lateral segments, each marked by six small tubercles, so arranged as to form longitudinal lines on the axal and lateral lobes; distinct margin. Cephalothorax, including the neck segment, one-third of the whole length: thorax rather less than a third: abdomen rather more.

Locality—Kildare, in limestone; St. Doolagh's, Dublin; Tyrone, Carnteel, in dark limestone.

PHILLIPSIA *ornata.*—Plate XI., figs. 2 a, 2 b.
ASAPHUS *truncatulus*—(Phillips).

This specimen is imperfect; the form of the glabella approximates closely to that of the preceding species; it does not, however, extend, as in it, to the points of the cheeks or posterior edge of the margin, and its furrows are more strongly marked. The furrows are ornamented by tubercles, and the whole surface is granular. The tubercles of the pygidium are more elevated, but its general form is nearly the same as that of P. Kellii, and it closely resembles Asaphus truncatulus. Fig. 4, is a monstrosity, in which the upper side segments of one side have been singularly distorted. Contributed by Lieut. James.

Locality—Hook, County of Wexford.

PHILLIPSIA *Jonesii*.—Plate XI., figs. 3 a, 3 b, 3 c, 3 d; fig. 5, Var.

Of Professor Phillips' figures, the nearest to this species is Asaphus seminiferus, Plate XXII., figs. 8, 9, and 10; fig. 8, is merely the glabella which resembles that of our fig. 5, though it is somewhat more elongated in proportion to its breadth, and not contracted, in the middle, as our specimens so strikingly are.

General form, elongated oval, but coiled up in the first specimen. Total length of fig. 5, an elongated variety, 1·2″; breadth, ·9″. Cephalothorax rather more than one-third of the total length; thorax, considerably more than one-third; abdomen, less than one-third.

CEPHALOTHORAX, elevated, bounded by a margin, or wings which blend in front into the glabella, and end posteriorly in slightly elongated points. *Glabella* rounded in front, but from its great breadth has a rectangular appearance; breadth, more than one-half of the total breadth of the cephalothorax, and equal to four-fifths of its own length; about the middle it is very much drawn in or contracted, which is an excellent specific character; cephalothoracic furrows strongly marked; surface either very finely granular or quite smooth; slightly convex. Anteriorly it appears to extend to the outer edge of the margin; but in reality a fine line marks the continuance of the margin over the front. *Cheeks* comparatively small, and occupied in great part by the very large lunate eyes, which extend forwards to the third furrow, and behind to the neck furrow. *Wings* or margin, when decorticated, striated. The small tubercle on the neck segment can be traced in this species. THORAX, fig. 5 b.—Segments quite smooth; the bend or knee of the pleuripedes is very near the axis, so that the animal has a very compressed appearance. PYGIDIUM.—Axal lobe about thirteen segments; lateral about ten. In fig. 3 d, the segments appear smooth and slightly forked at the extremities. In fig. 5 a, the lateral segments are thinner and more ridge-like, and exhibit very fine minute tubercles; it is, therefore, a variety. The margin is wide, but traces can be observed, by holding it in a fitting light, of the segments under it. The species is called after Captain Jones, M.P., who presented the specimens, and who has investigated with such success the mountain limestone fossils, particularly the fishes. In fig. 3 c, is seen the mode in which the segments slide over each other. The edge of the pygidial margin appears in some specimens striated; and in like manner on the thoracic segments, when the external crust is removed striæ transverse to the axis, are visible.

PHILLIPSIA *Jonesii*, var. *seminiferus ?*—(Phillips)—Plate XI., fig. 5.

The differences between fig. 3 and fig. 5 having been pointed out in the preceding description, it may be added that the cephalothorax in fig. 5, is longer in proportion to its breadth than in fig. 3; that the eyes, though large, are less so than in fig. 3, leaving more space on the wings; and taking these minute differences in connection with the small tubercles or granules on the segments of the pygidium, this may be considered a variety of the preceding. It approaches very closely to Phillips' species, though his glabella does not sufficiently exhibit the central contraction, and is proportionally wider at the base than is suited to this species.

Asaphus obsoletus, figs., 3, 5 of Professor Phillips, may possibly belong to this species, as in the cephalothorax, (fig. 3,) though imperfect, there is an appearance above the eye of the contraction of the glabella so strongly marked in the species; the lobes of the pygidium are, however, far too ventricose. The form and reticulation of the eye (fig. 5,) agree with the genus. Asaphus raniceps, fig. 14, may possibly be also referred to this genus, as the eyes are oblongo-lunate, and very minutely reticulated; but it cannot be judged from the figure whether the other characteristics were also present.

Locality—Kildare, in limestone; Donaghmore and Clonfeacle.

PHILLIPSIA *Maccoyi.*—Plate XI., figs. 6 a, 6 b, magnified.

Of this minute but very beautiful species, the cephalothorax alone has as yet been discovered. It is placed provisionally in this genus, though, from its diminutive size, some of the characters of the genus cannot with certainty be exhibited, such, for example, as the furrows of the glabella or the reticulation of the eyes.

CEPHALOTHORAX elevated; general form oval, approaching to semicircular; length. ·17″, breadth, ·25″; glabella very small, in length rather more than two-thirds of the length, and in breadth one-fourth of the total breadth of the cephalothorax; the eyes apparently smooth, lunate, and equal in length to two-thirds of the height of the glabella; the cheeks are large, slightly convex, separated from the margin by a furrow which joins the neck furrow, and are continuous, passing in front round the glabella. Margin or wings elevated, and ending at the posterior angles in prolonged points; the whole surface is covered with granulations which are arranged along the ridge of the margin and the supra-palpebral line of the eyes like beads.

This species was communicated by Mr. Frederick M'Coy, a young gentleman who is cultivating with much success the study of fossils. The general form will doubtless recall that of Zenker's genus Otarion; but in this, the place of the ear-like appendages, which suggested the name Otarion, is occupied by true eyes.

Locality—Kildare, in limestone.

The determination of the true genus of the other mountain limestone

Trilobites to be now described, is attended with considerable difficulty, as no fully expanded specimen has yet been found. In Pl. XI., fig. 9, however, enough has been preserved to give, in connection with fig. 7, a general idea of the forms of the cephalothorax and pygidium, and of the structure of the thoracic segments. The form of the cephalothorax, and the position and arrangement of the eyes, resemble closely the genus Asaphus as restricted, and particularly Asaphus expansus and Hemicrypturus Razamowskii of Green; but in fig. 7, there is a perfectly developed pygidium, closely resembling that of Phillipsia. From the abundance of such pygidial relics, and the total absence of any other, it may fairly be presumed that a pygidium with axal and lateral segments fully developed, was a generic peculiarity. The glabella is also more elevated than in the true Asaphs. In the absence of perfect specimens the formation of a new genus is difficult; but since the group is distinguished from the Asaphs of older rocks by the fully developed pygidium, it is advisable to separate them. It may also be here remarked, that Green's cast of Hemicrypturus Razamowskii, and Pander's figures of Asaphus expansus, seem to show that the lateral segments of the thorax in those species were compound as in Phacops, and Calymene, whereas they are merely folded in Asaphus latifrons of this work; in the species here figured, they are also compound, so that there appears to be a blending of the characters of the several sections one into the other. See also Pl. XXIV., fig. 12, a beautiful specimen presented by Captain Jones.

GRIFFITHIDES.

CEPHALOTHORAX, semi-oval, longitudinal; glabella strongly marked and gibbous; rounded in front, narrowed posteriorly into an obsolete neck, with a furrow more or less distinct on each side; *cheeks*, triangular spaces, very slightly convex; *wings*, either ending in an angle posteriorly or prolonged backwards in a flattened spine. Eyes, near the axis, not large, lunate, smooth? The minute neck tubercle sometimes present.

THORAX.—The pleuripedes are compound; in number 9, or with the neck segment, 10.

PYGIDIUM.—Fully developed, and strongly resembling that of Phillipsia.

A genus replacing the Asaphs and Phacops in the Carboniferous system; it is dedicated to Mr. Griffith.

GRIFFITHIDES *longiceps*—(Portlock)—Plate XI., figs. 7 a, 7 b.

This species, from a casual examination of the abdomen, would be considered equivalent to Phillips' Asaphus gemmuliferus; but in that species the number of elevated puncta is stated to be six on each axal and lateral segment; in this species the number is about twelve, being small and closely set together; it is therefore more like Phillips' (Pl. XXII., fig. 10,) or the abdomen of Asaphus seminiferus; but the head (fig. 8) appropriated to that species, renders it impossible to assimilate it to this. *Glabella* elevated; rounded and swollen in front, but narrowing gradually towards the base; the external surface covered with minute dots, and, when removed, the surface below appears granular or rugose; length rather more than four-tenths of an inch; breadth in front three-tenths, and at the base three-twentieths; eye projection very small and near the base. THORAX imperfect, but showing the lateral segments to be compound. PYGIDIUM, in length four-tenths, breadth five-tenths of an inch; axal lobe elevated; segments thirteen, with about twelve granules or small tubercles on each, and a rounded extremity also covered with granules; lateral segments about nine on each side, with a row of small tubercles on each, not quite extending to the margin which is flattened, or turned up, and strongly striated on the edges and under surface. The prolongation of the segments is marked by slight elevations on the margin; the flattened and turned up margin of the pygidia of this genus is generally more striking than in Phillipsia, in which the pygidial margin follows the slope of the lateral segments, but the character depends in part upon the condition of the crust, being more marked when it is decorticated. Fig. 8 is a larger individual, of probably another species; the surface is granular, and it is proportionately flatter; it may be called G. platyceps.

Locality—Tyrone, *Carnteel, Donaghenry, Donaghmore, Clonfeacle.*

GRIFFITHIDES *globiceps*—(Phillips)—Pl. XI., figs. 9 a, 9 b.

Glabella short and almost globular in front; length four-tenths, breadth three-tenths of an inch; greatly elevated above the cheeks; narrowed at the base to less than one-half the breadth in front; *cheeks* triangular, slightly convex; *eyes*, short, lunate, connected with the glabella by a projection or nucleus; no visible reticulation; the *wings* end posteriorly in sharp angles, and in perfect specimens appear strongly striated; the margin is raised above the level of the cheeks; the neck furrow is deep; total breadth of the cephalothorax more than seven-tenths of an inch. This is referred to Professor Phillips' species, as it agrees closely with it in the characters of the cephalothorax, and is noted by him as occurring in the County of Kildare. His figures 19 and 20, leave some doubt as to the true generic position of the species, as the separation of the thoracic from the pygidial segments is not shown, and it would almost appear that the former are more numerous than is consistent with the genus. Professor Phillips further observes that this species agrees better than any other with Martin's Entomolithus Derbyensis; there are certainly some strong points of resemblance, particularly the form of the cephalothorax and glabella—the position of the eyes and the striated margin. Martin, however, states the eyes to be distinctly reticulated, and as the small tubercle on the neck segment, and the minute tubercles on the segments generally, have not yet been noticed in this species, whilst all three characters have been observed in Phillipsia, Martin's specimen probably belonged to the latter genus. The probable abdominal portion of Martin's figure, would correspond with the form of pygidium given in the preceding species, and the total number of the segments of his species would admit of a division into thoracic and abdominal, suitable to the genus, so that, although a doubt must exist as to the identity of Professor Phillips and Martin's species, and even genera, the comparison affords some confirmation of the propriety of the allocation of this and the preceding species to the same genus. The pygidium of Asaphus obsoletus (Phillips) probably belongs to this species.

Locality—Kildare.

GRIFFITHIDES *longispinus.*—Plate XXIV., fig. 12.

This beautiful species approximates to G. longiceps, as the specimen figured in Plate XI., fig. 9, is imperfect, and may, therefore, have had lateral spines; there are, however, some good marks of distinction, the glabella is not quite so long nor so narrow, and the pygidium is rather longer, has fifteen axal segments, and is smooth, whilst the thoracic segments are granulated; these may, however, be only, in part, accidental variations from peculiar circumstances, wear, &c. The glabella is gibbous and longer than in G. globiceps. The wings pass anteriorly under or in front of the glabella, and are prolonged backwards in long, flat, striated spines—(See magnified view, fig. 12 b). Though the granulations are well marked on the thoracic segments (fig. 12 e), none are visible in this specimen on the pygidium (fig. 12 c); when decorticated a large striated and nearly vertical margin appears, as in fig. 12 d, which also shows that the under surface does not exhibit the extension of the segments to the margin which is seen on the upper surface of the crust, and hence that in the two conditions they might appear different fossils. Specimen contributed by Capt. Jones.

Locality—Kildare, in limestone. Tyrone, *Carnteel.*

In addition to the figures alluded to in the description, fig. 12 appears to be either a species or a variety in which the tubercles extend to the very border of the margin; and fig. 13 is wider in proportion to its length than the species described, as the margin is not turned up they probably belong to the genus Phillipsia. Such, then, are the genera and species of Trilobites occurring in the mountain limestone, so far as the present state of inquiry will allow them to be determined; and in comparing them with the Trilobites of the underlying strata, it is impossible not to see the very marked difference between the two; one amounting not merely to specific but to generic distinction; for although in the case of the genus Griffithides, it is difficult, with the present data, to separate it as a generic group from the Asaphs of the Silurian system; there is at least strong reason to consider such separation well founded. This investigation has, therefore, been fully effective in establishing the zoological difference as regards the family of the Trilobites in these two sets of strata, as exhibited in Ireland. In the shales associated with the limestone or with the grits of the lower portion of the Carboniferous system, other crustacea occur which will be now described.

DITHYROCARIS—(Scouler).
ARGAS—(Scouler.)

In the Records of Science, for February, 1335, Dr. Scouler first noticed this remarkable crustacean, found by him in the Carboniferous strata of Paisley; and depending as a principal character on the lateral caudal appendages, he pointed out its analogy to the genera Cyclops and Apus; and, again, at the meeting of the British Association at Glasgow, he described two species, one of which, Argas tricornis, in all probability depends on an illusive appearance produced by the overlapping of the crusts of different individuals. In respect to the force of the analogies it may be observed, that the buckler, or cephalothorax of this genus is composed of two pieces, in the form of valves, united together, the hinge of which is on the back, a characteristic of the order Lophyropa, to which the genus Cyclops belongs, and that the caudal portion is visible and divided into segments; but the analogy there ceases, as there is no division of the body into segments as in Cyclops, the buckler is distinctly composed of two pieces, and the caudal appendages have a totally different form and character. Dr. Scouler having subsequently altered his view of the affinities of the genus, he now considers it a bi-valved crustacean, distinguished by not being able to retract the tail within the shell, and hence has named it Dithyrocaris, or bi-valved shrimp, abandoning the original name as one already pre-occupied. On examining, however, the numerous specimens, of what at present must be considered a new species, found in the shales of the lower portion of the Carboniferous system in Ballynascreen parish, County of Derry, and Clogher parish, County of Tyrone, some doubts have arisen as to this view of the affinities of the genus. In all the specimens the valves are almost if not quite flat, and if found united are always spread out as in Plate XII., fig. 1; the hinge or line of junction being a single, raised, and notched keel, which appears to negative entirely the idea of any motion between them, and consequently of opening and closing. The flatness of the valves is also an argument against their closing, as the space between them would be insufficient to receive anything but a body as thin as paper, and would require the caudal portion to be in the plane of the valves, as they could not close over, without crushing it, when in a horizontal or transverse position. Considering, then, the buckler as actually constituting one whole, though formed of two pieces, the strongly marked and notched keel not being a hinge, the affinities become stronger with the seventh order, or Phyllopoda, and the nearest analogues will be the genus Apus and Lepidurus, though it differs in many important particulars from both. The shell is not uniformly rounded in front as in Apus, but the valves curve inwards towards each other, so as to form, where they meet, a re-entering angle. The same effect is produced posteriorly, where the valves meet the keel, and turn backwards in a projecting point, showing a much more complete bi-valve structure than in any of the other genera. From the twisting evident in fig. 1, it is probable the shell was very thin and membranaceous. Not having yet received Dr. Scouler's generic characters, I shall merely describe the species.

DITHYROCARIS *Colei*—(Portlock)—Plate XII.

One of its most striking peculiarities is found in two lines, one on each side of the central line or keel, which are anteriorly bent towards that line and then continued in a short parallel prolongation. They resemble the lateral lines of fishes, and are notched in the same way as the central keel; posteriorly they are continued to the margin. The general form of the whole buckler, independent of what appears to have been a membranaceous margin is oval; the sides are anteriorly rounded into an angle or notch, and in a similar manner rounded behind, into a re-entering space. The posterior end is rather wider and more flattened than the front; there is also a small backward turn and projection of each pseudo-valve at the central line, supporting so far the idea of two pieces. External to the rim, which is marked by raised lines, there is a marginal space, widening from the front backwards, where it ends in a sharp point just opposite the termination of the side lines; this, as shown in fig. 2, is finely striated, and has much the appearance of the dorsal fin of a fish; it was probably membranaceous. Of the caudal portion (figs. 3, 4, 5,) it is impossible to speak with certainty from the specimens; it appears, however, to have been wide and flat, and to have had two or probably three exposed segments; that they were exposed is evident from the serpulæ (fig. 3 a b) thickly attached to them. When the thin membranaceous crust was removed, fine lines appear, as in fig. 4, 5, and partly in fig. 3, where the lines are differently directed to those of the other figures. The tail is terminated by three appendages of nearly equal length; the central one, which is apparently the prolongation of the tail, as in Lepidurus and Limulus, is triangular, and forms a strong projecting spine; on each side of it, and close to its base is another, which appears articulated to the tail; these are also triangular, having a strong notched ridge on one side and a flat surface on the other, the impression of which leaves the linear marks seen on figs. 3, 4, as also on the centre appendage of fig. 5. It is probable that a membrane was attached to and strengthened by the spine or ridge. Fig. 6, represents bodies which are frequently found on the specimens of this crustacean, and in this instance together, as represented in the figured specimen: they each exhibit a single row of tubercles, and were in all probability connected with the masticatory apparatus, which it is probable, therefore, was highly developed in this large species.

As a further means of distinguishing the species, the position of the lateral lines may be noted, and the following dimensions taken into account:—

Length of Buckler of large specimen, .	3·5″
Total breadth of ditto, ...	2·6
Breadth of single valve, ...	1·3

The lateral line is nearer to the margin than to the axis, though with some variation; if, therefore, it be prolonged through the valve and considered a chord, the length would be 3·1″, and the versed sine or perpendicular from that line to the margin, ·7″, or less than one-fourth of the chord.

Dedicated to the Earl of Enniskillen.

Locality—Tyrone shales, *Clogher*; Derry shales, *Ballynascreen*.

DITHYROCARIS *orbicularis*—(Portlock).

A single specimen of a single valve, requires from its proportions to be separated from the preceding species, as there is no approximation, even with a diminished size, in any of the other specimens to this form. It may be distinguished by the following proportions and characters:

Valves rounded and very wide; being more than semi-circular, hence the general form would be orbicular and rather transverse. The length of the single valve ·6″, breadth ·4″. The lateral line prolonged, would form a chord nearly as long as the axis, and the versed sine would be ·25″, or more than one-third of the chord, a proportion very different from that of the preceding species. The axis and lateral line are finely beaded, and the margin of the valve has a rim also finely beaded or granular, but without, on this specimen, any external or membranaceous expansion.

Locality—Derry: *Ballynascreen* shale, White Water River.

LIMULUS *trilobitoides*—(Buckland ?)—Plate XXIV., fig. 11.
ENTOMOLITHUS *monoculites* (*lunatus*)—(Martin).

Two casts in shale of this species are the only specimens which have been found. They approach nearer in form to Martin's figure than to Dr. Buckland's, and it may be reasonably conjectured that there are more species than one; the very striking difference in the structure of the abdomen constituting a sound basis for even generic distinction. In this specimen the buckler resembles the recent Limulus far more than Dr. Buckland's figure does, in which it is represented transverse, being considerably wider than long; it has probably had lateral spines, but the cast does not exhibit them: and the caudal spine is also lost in the cast. The trilobation and segments of the abdomen are quite distinct, and very like that of Martin's figure.

Locality—Derry, *Maghera*.

CYPRIS *Scoto-burdigalensis*—(Hibbert)—Plate XXIV., fig. 13 c.

This is a magnified view of the smaller Cypris, on the slab 13 a. It is much rounded, and being convex, would, when the valves were closed, have an egg shape, as described by Hibbert. The hinge is also straight. The covering is thin and white and easily peels off.

Locality—Derry, Tyrone, Fermanagh; shales.

CYPRIS *sub-rectus.*—Plate XXIV., fig. 13 b.

This is a magnified view of the larger species on the slab. It is more elongated than the last; has nearly a straight hinge, there being a slight inward curve, and attains a considerable size, nearly ·12″. It has also the thin white covering, and a small tubercle is sometimes seen on one of the valves. In form it closely resembles Cytherina phaseolus of Hisinger, but is much smaller. The Cypris is met with in many of the shales of the Carboniferous system, and is often associated with bodies of a marine origin.

Locality—Derry, Tyrone, Fermanagh; shales.

Plate XIV. A.

This serrated body is here classed with the crustacea, and is probably the claw of some minute species of a higher order.

The geological distribution, therefore, of the crustacea here described, is—

Trilobites	Silurian	52	
	Carboniferous	8	60
Entomostraca allied to Limulus,	Silurian	0	
	Carboniferous	3	3
Cypris	Silurian	0	
	Carboniferous	2	2
Probably of a higher order,	Silurian	0	
	Carboniferous	1	1
	Total,		66

And in this great number there is no confusion; no mixture of those of the Silurian with those of the Carboniferous, as not merely the species of the two great formations are distinct but also their genera; and as yet no intermediate strata exhibiting such a mixture have been found in this district.

Zoophyta.

The Zoophytes of the Tyrone and Fermanagh Silurian strata are not numerous; but as they include the remarkable genus or rather family of Graptolites, the comparison between them and those of the Carboniferous system is still very striking. The Graptolites in this respect take the lead, as being at present one of the most distinguishing fossils of the Silurian strata. Of their position in the animal kingdom three different opinions have been advocated: Schlotheim referred them to the genus Orthoceratites; Professor Neilson to the Sertulariadæ, and Dr. Beck, in his

"Note on Graptolites," supplied to Mr. Murchison and published in the Silurian system, to the Pennatulinæ, or Sea Pens, considering the Linnæan genus Virgularia as the nearest existing form to which they may be compared. Still more recently, Professor Quenstedt, of Tubingen (Neues Jahrbuch, 1840), has revived the opinion of Schlotheim, and advocated their reunion with the Orthoceratites. He rests his principal argument on the appearance of septa, which in certain conditions of wear is rather striking (see Plate XX., figs. 3, 4); and he considers the serratures of the stem as illusive appearances produced by unequal wear. The size of the specimens he possessed, which were only from two to three inches long, had doubtless some effect in inducing this opinion; but it will be shown that they are found a foot long, and doubtless have been much longer, though without any visible alteration of their thickness or of their form. Such long, thin, generally rigid, serrated bodies seem to have no affinity to Orthoceratites, and the appearance of septa may be considered to indicate the connection of the polype cells with the internal axis. The two divisions, Sertularia and Plumularia, seem analogous to the double and single Graptolites; but the simple stems of the latter, which have no branches, nor even pinnæ, are strikingly distinguished from those of the former. The cell-like structure of others, as seen in Plate XX., figs. 3, 4, and in Hisinger's Prionotus scalaris is more analogous to the Cellaria —(see for example the genus Canda, Lamoroux)—and it is probable, therefore, that these remarkable bodies should in reality be formed not into one, but into several genera, belonging even to more than one order. It is not, however, intended to attempt such a division here.

GRAPTOLITHUS } *Sedgewickii*—(Portlock)—Plate XIX., fig. 1.
PRIONOTUS }

True axis capillary; appearing in some specimens elevated, in others depressed; hence showing that it was round, elevated, and either solid or tubular; between this and the serratures is a flattened space which may also be considered as part of the axis or stem; in large specimens this space is ·04 inch wide. The serratures are strong projecting hooks having a wide base, or generally a triangular form, the apex being continued and bent into a hook. The distance between the curved portion of the hooks is fully equal to the diameter of the

the stem. In some specimens the hooks and stem are uniformly flat, in others there is a triangular depression at the base of the hook, as if it had been formed by a corresponding elevation in the original. The much greater extent of the projection of the hooks or serratures beyond the axal portion, and the greater distance between them, strongly distinguish this species from G. Ludensis (Murchison), or G. sagittarius, (Hisinger). The connection of the serratures with the capillary axis by fine nerve-like striæ is rarely and then scarcely traceable. It attained a very great length without any appearance of branching; one specimen (only a fragment of a larger,) being eleven inches long.

Mr. Murchison's name having already been assigned to one species of Graptolite, I have given that of Professor Sedgewick to this species, he being the other great expounder of the more ancient Fossiliferous strata. Plate XIX., fig. 2, represents a portion of a slab eight inches square, covered over with specimens of this species, and an occasional example of what perhaps should be separated and classed with the next species. Fig. 3 a, represents this species as it appears sometimes with a depressed and sometimes with an elevated axis; and 3 b, shows the triangular depression visible in some specimens; 6 a, 6 b, exhibit similar appearances with a more delicate form, and it may be here observed that the stem appears to decrease in size on approaching the end towards which the hooks bend, a reason for supposing that it was not fixed.

Locality—Tyrone, Desertcreat. Sheet 37, No. 18: fine schists.

GRAPTOLITHUS *distans*.—Plate XIX., figs. 4 a, 4 b.

Axis capillary; stem narrow; hooks depressed to the stem at their base, and more distant at their curved points than in the last species. Though occasionally appearing very distinct, this may possibly be a variety only of the last species.

Locality—Same as preceding.

GRAPTOLITHUS *tenuis*—(Portlock)—Plate XIX., fig. 7.

Stem capillary, with small, adpressed, spines on one side, forming an obscure serrature. This is a very delicate species.

Locality—Same as preceding.

GRAPTOLITHUS } *convolutus*—(Hisinger)—Plate XIX., fig. 5.
PRIONOTUS }

"Linear; spirally convoluted, a line wide, compressed; axis marginal, capillary; serrated on one side, the teeth being separated to the base;

lanceolate and acute." It appears doubtful whether this is not a twisted variety, or even one end of Graptolithus Sedgewickii.

Locality—Same as preceding.

GRAPTOLITHUS } *Sagittarius*—(Hisinger)—Plate XIX., fig. 8.
PRIONOTUS }

" Linear, straight, several inches long, half-a-line wide, compressed; axis capillary and marginal; the opposite side with transverse distant dissepiments and a serrated margin."

To this species I refer the specimens figured Plate XIX., fig. 8 a b, and Plate XX., fig. 4; it differs from Murchison's G. Ludensis in the serratures not being curved over or hooked as in that species.

The appearances of this fossil according to its condition of preservation are very various, as may be judged from fig. 8 a b, and Plate XX., fig. 4. Like G. Sedgewickii, it attained a considerable length; the specimen, Plate XX., fig. 4, though bent, having evidently been at least six inches long. It sometimes appears (Plate XIX., fig. 8), as if composed of a wide flat stem, having a serrated margin; but in other specimens, the fine nerve-like striæ are visible, connecting the serratures with a capillary axis, as in the lower magnified view, fig. 8 b, the serratures extending very little beyond the margin; and the appearances of elevated and depressed portions, and of an occasionally more foliated aspect, are shown in the three fragments above. Most of these appearances are combined in Plate XX., fig. 4, and in addition a portion with dissepiments, producing a chambered appearance, which is doubtless what has induced Quenstedt to revive for these remarkable bodies the theory of orthoceratite analogy.

Locality—Fermanagh: Lisbellaw schists.

GRAPTOLITHUS *pristis* }—Plate XIX., fig. 10.
PRIONOTUS *pristis*—(Hisinger) }

" Linear, straight; scarcely a line broad; compressed, with a central capillary axis, having sharp broad teeth on both sides." This is frequently found, as represented, with a portion of the very delicate axis, free from serratures. Figs. 11 a, 11 b, more robust variety, in which the central portion rises into a sharp ridge, producing in an impression a triangular furrow. Under some conditions part of the substance being removed the impression assumes the more flattened leaf-like look of the serratures of fig. 9 c. The figure of Murchison's G. foliaceus, drawn of the natural size, appears nearly identical with G. pristis; but the magnified view seems to differ from it slightly in the length of the serrated portion as compared with the stem. Fig. 9, also approximates to Murchison's species, G. foliaceus, which occurs in the Tyrone schists.

Locality—Fermanagh: Lisbellaw schists.

Prionotus *folium*—(Hisinger) } —Plate XX., fig. 5.
Graptolithus—(Linn.) }

Hisinger's description:—"Oblong, lanceolate, straight; two lines broad; compressed, having a central capillary axis with pinnules on each side which are linear, slightly acute, closely set together, and project at the margin in an acute angle." The fossil thus described by Hisinger is, according to his figure, Lethæa Suecica, Tab. 35, fig. 8, 1·12″ long and ·25″ broad; the sides are quite parallel, and the ends being semi-circular, it has a blunt appearance. In the magnified portion, the curvature of the ends is less abrupt, sloping more gradually into the sides, and agreeing, therefore, more closely with the specimen here figured.

The Irish variety may be thus described:—A thin, leaf-like, almost membranaceous expansion, having a central capillary axis, from each side of which thread-like ribs, at an acute angle with the axis, proceed to the margin, beyond which they project, so as to form a distinctly serrated edge; some of these ribs are quite straight, but others at the base are slightly curved as in Hisinger's figure; length ·44, breadth ·25 inch. This can only be considered a fragment, and would, if lengthened, still more closely resemble Hisinger's figure.

Locality—Fermanagh, Lisbellaw schists.

Plate XX., fig. 2.

One portion of this specimen has the ordinary appearance of a Graptolite; but another, where probably weathered down, exhibits curved lines like septa.

Locality—Fermanagh, Lisbellaw schists.

Plate XX., fig. 3.

Here are distinct transverse furrows, on what appears to be a cast, which are much like the spaces occupied by septa, though proportionately too thick. It resembles Hisinger's Prionotus scalaris, which is described as "linear, straight, an inch long, scarcely a line wide, compressed, with a central capillary axis, and transverse alternate dissepiments on each side," except that it is single; it is, however, probable that figs. 2 and 3 are the same body under different modifications.

Locality—Fermanagh, Lisbellaw schists.

The family of Graptolites has at present no known representative in the Carboniferous system; although a specimen from the mountain limestone, belonging to Captain Jones, M.P., has a very strong resemblance to some of the double Graptolites. They are most abundant and varied in the finer, or what may be called the mud schists, and should, therefore, be expected in beds of shale. At the Lisbellaw locality, in Fermanagh, where the Silurian schists are in contact, and alternate, with conglomerates (Plate G., fig. 6), they are still in great abundance, though partly of other species than those found, geologically lower in the system, in Tyrone; but ascending into the lower shales of the Carboniferous strata no trace of them has been hitherto discovered, they are, therefore, peculiarly a Silurian fossil.

In respect to the next genus (Gorgonia), it is very doubtful whether the Silurian species, here provisionally referred to it, are true Zoophites. They are abundant in a limited portion of the schists, and one species extends beyond the Silurian system into the coarse, highly calcareous, shales of Tyrone (Sheet 68, No. 27). No crust or cells have as yet been discovered, and the internal stems are very fine, or wiry; hence it is very possible that these bodies approximate more to Corallina and are not of animal origin. Ascending into the Carboniferous system, they are replaced by Lamarck's family of Zoophytes with reticulated Polyparia, not one of which has been noticed in the Silurian strata of this district. The exception in the upward extension of one species of Gorgonia from the Silurian to the Carboniferous system, is of considerable interest, as affording a glimpse of the transition Devonian system.

GORGONIA *undulata*—(Portlock)—Plate XX., fig. 8.

It is very difficult to decide as to the true nature of some of these fossils; but they appear to have more analogy with the axis of Gorgonia than with any other body. The stems are faintly striated under the magnifier, or rather, as in Gorgonia, appear compounded of minor threads, and irregularly anastomose, by undulating and meeting at the bends. Some are much more loose, as in the figure, than others. This approximates to G. assimilis of Murchison: but in that species the network is more regular. Around the base there is sometimes spread a black glossy substance which extends occasionally over the stems.

Locality—Tyrone, *Desertcreat*, Silurian schists.

GORGONIA *assimilis*.

In this there is a regular anastomosis, as in Mr. Murchison's figure. Locality—Tyrone, *Desertcreat*.

GORGONIA *capillaris*—(Portlock)—Plate XXI., fig. 1.

In this the stems are very fine and cross each other in a very confused manner, like uncombed hair; it may, however, be only a variety of G. undulata.

Locality—Tyrone, *Desertcreat.*

GORGONIA *regularis*—(Portlock)—Plate XX., fig. 6.

Grows from a central attachment into a circular flattened expansion. The stems are slightly branched; wiry; rather distant, and united by regular dissepiments.

Locality, Desertcreat. The schist shaly and slightly calcareous.

CARBONIFEROUS.

FENESTELLA *polyporata*—(Phillips)—Plate XXII. A, fig. 1.

"Interstices thick; fenestrules large, irregular; pores numerous, small, round." It is difficult to mark a tangible line of distinction between this species and F. laxa, more especially as Phillips notices the proximity of F. laxa to Goldfuss' Gorgonia ripisteria, which in size of fenestrules and general appearance more strongly resembles the smaller than the larger species. Phillips does not mention the obverse of F. polyporata; in our specimens it appears smooth, though under a magnifier a row of fine granules may be occasionally noticed running along the centre of the branches, and under a favorable light traces of striæ may be discovered. Though not fully represented in the figure 1 d, there is an angle, very slightly marked, between the lines of pores.

Locality—Benburb, in shales.

Plate XXII., fig. 3.

This is figured to show the great variation in apparently the same species. I first considered this example, in which the fenestrules are nearly regular, distinct from F. polyporata; but some specimens are found in which the lower portion is quite as irregular as in Pl. XXII. A, fig. 1, and the upper as regular as in this species, figs. 3 b and 3 c.

Locality—Benburb, in shales.

FENESTELLA *laxa ?*—(Phillips).

Two specimens of a flattened species, in which the irregular openings of the net-work are very large, have been contributed by Capt. Jones;

in the one in a black calpy limestone, the fenestrules are nearly ·5″ long and ·25″ wide; they are rounded at one end and angular at the other; this may possibly be a distinct species. In the other specimen the fenestrules are not quite so large.

Locality of the larger variety—Malahide, on the sea-shore.

FENESTELLA *intertexta*—(Portlock)—Plate XXII. A, fig. 3 a, 3 b, 3 c.

Interstices or branches thick, and forming very irregular fenestrules by anastomosis, there being no regular dissepiments. The growth was curious; commencing from a centre, the branches coalesced into a uniform plain expansion slightly concave above, and then again separating were irregularly united by anastomosis forming a very rude net-work. In the centre of the concave space there are several conical tubercles, proceeding it would appear from the base of attachment below; the surface above is smooth, below it is covered with numerous irregularly disposed prominent pores. The branches are rounded both above and below, and there is no angle or ridge; hence in many points this coral deviates from the characters of Fenestella, and agrees better with those of Retepora.

Locality—Benburb, in shales.

FENESTELLA *flabellata*—(Phillips)—Plate XXII., fig. 1.

"Interstices straight, mostly equidistant; fenestrules elongated, rectangular, equal; dissepiments very thin; pores small, prominent; reverse of the interstices, striated." The peculiar straightness of the interstices gives this species a rigid, wiry look, more so generally than in the figure, which is part of a large expanded specimen. The fenestrules are sometimes shorter than at others, and the dissepiments are sometimes opposite, sometimes alternating, and sometimes intermediate between the two. On the reverse there are two rows of pores, the centre of the interstice rising to an angle between them. Sometimes the interstices (Plate XXII. A, fig. 4,) are united by the pores of one extending and uniting themselves to those of the opposite one.

Localities—Tyrone, calcareous shales; Fermanagh, calcareous shales; Benburb, calcareous shales; The Hook, on dark limestone.

FENESTELLA *tenui-fila*—(Phillips).

It is probable that some of the more delicate of these specimens belong to this species, though the distinction between it and F. flabellata seems evanescent. It is associated with Favosites tumida.

Localities—Tyrone, shale on blackish-grey limestone, associated with numerous encrinital columnar joints. Sheet 64, No. 49.

FENESTELLA *irregularis*—(Phillips)—Pl. XXII. A., figs. 2 a, 2 b.

"Interstices thick, dissepiments not quite as thick; fenestrules irregular, some nearly oval, others more angular; pores not distinct on the specimens; on the obverse the fenestrules oval."

Locality—Wexford. *Hook Point:* shale on limestone. Tyrone, *Aghalurcher* parish, Sheet 64, No. 40, shale.

RETEPORA *prisca*—(Goldfuss)—Plate XXII. A, figs. 5 a, 5 b.

Goldfuss describes his species as forming flat expansions, having on one side oblique rows of oval openings, and on the other parallel keeled ribs, with two rows of cells; his figure shows in addition that the ribs are slightly flexuous, and this latter character is perfectly visible in the specimen here figured. There are from four to five round pores in the space of a fenestrule; they are separated by a space less than their diameter from each other, and the bending lines tend to bring the pores of opposite interstices close together. In all these points, our specimen agrees better with R. prisca, than with R. flustriformis of Phillips; if therefore it be ascribed to Goldfuss' species, it becomes another example of the feather-form growth, and his description should be therefore enlarged to include that peculiarity.

Coral growing from a round repent stem, which, on the cellular surface, runs into a strong angular midrib, from which proceed, at an angle of 45 degrees, branching, slightly flexuous, nearly parallel, and angular, side ribs; a row of cells on each side of the midrib, and also on each side of the side ribs. R. prisca of Goldfuss, appears to be, as was also suggested by Phillips, distinct from Fenestella prisca of Lonsdale.

Locality—Wexford. *Hook Point.*

SILURIAN.

CATENIPORA *escharoides*—(Lamarck) and Lonsdale in the Silurian System.

Plate XX., fig. 9, is C. labyrinthica (Goldfuss); the tubes are quite oval.

Locality—Tyrone, *Desertcreat.* Not noticed in the higher strata of this district; a variety smaller than the specimen figured, is abundant at Portrane, County of Dublin.

FAVOSITES.—The Favosites in the Silurian system of England are tolerably abundant, six species having been figured by Mr. Murchison. The range of some of them is considerable, of three from the Caradoc sandstone to the Aymestry limestone, but that of the others is more limited, Favosites polymorpha having, in the English Silurian system, been only noticed in the Aymestry limestone and Upper Ludlow, though it is carried into the Devonian by Professor Phillips: it is the only species as yet noticed in the Tyrone Silurian strata. Two other species of the English Silurian system occur here beyond its limits, and again indicate an approach to a Devonian system.

FAVOSITES *polymorpha*, var. }
CALAMOPORA *polymorpha* } (Goldfuss)—Plate XXI., fig. 2 a.

Irregularly ramose. In the size of the tubes and general character, this is intermediate between F. polymorpha and F. fibrosa.

Locality—Desertcreat schists, therefore low down in the Silurian system; rare.

It is remarkable that the allied Zoophite Stromatopora concentrica is abundant in the Tramore Silurian strata, but is not found here.

Fig. 2 b is the impression left by the open tubes; it represents the casts of their apertures.

STROMATOPORA *polymorpha*—(Goldfuss)—Plate XX., fig. 9.

This is the only specimen, an impression left by the external surface of the coral and its tubes (see, for comparison, Pl. XXI., fig. 2 a). The surface must have exhibited the mammillated character represented by Goldfuss.

Locality—Desertcreat schists, rare; the only specimen is a fragment.

INTRICARIA? *obscura*—(Portlock)—Plate XXI., figs. 4 a, 4 b.

This is an obscure fossil, but appears to have the curious anastomosing structure of the genus, though nothing further can be determined respecting it.

CARBONIFEROUS.

FAVOSITES *tumida*—(Phillips)—Plate XXII., fig. 4.

Irregularly ramose, and occasionally tumid. Tubes very small, so that the species, in all probability, merges into F. fibrosa, var. β. of Goldfuss; and Phillips also remarks that it approximates to that species.

Locality—Tyrone, *Clogher*, Benburb, in shale.

FAVOSITES *Gothlandica*—(Goldfuss).

Mr. Lonsdale unites the two species F. gothlandica and F. basaltica.

Our specimen strongly resembles the figure given by Hisinger of F. basaltica. The tubes are regularly prismatic, and about ·1″ in diameter.

Locality—Gritty limestone; Tyrone, *Derryloran.*

FAVOSITES *fibrosa*—(Goldfuss).

In this species the tubes become very minute, though still perceptible by the naked eye. On the cross section, the sides of the tubes produce a wiry fibrous appearance. They are sometimes slightly waved, as represented by Lonsdale. The connecting foramina at the angles occasionally visible. First specimen contributed by Captain Jones.

Locality—In the detritus of Armagh, very siliceous; in situ, Donaghenry parish, and Derryloran.

Captain Jones remarks that he has never found silicified fossils, in situ, in the Armagh limestone, though they are frequently found in Fermanagh and Tyrone.

F. septosus and F. depressus probably belong to one or other of these species, the mode of growth being variable.

FAVOSITES *capillaris*—(Phillips).

In this species the tubes become so very minute, that it requires a magnifier to detect them. It forms large spheroidal masses in the reddish limestone of Armagh. Specimen belongs to Captain Jones.

Within this district, therefore, the cognate genera Favosites and Stromatopora maintain their distinctive characters in the two great Palæozoic formations; but two of the species, F. gothlandica and F. fibrosa, which extend, in the English Silurian strata, from the Caradoc sandstone to the Middle Ludlow, or Aymestry limestone, and are recorded by Professor Phillips amongst the Devonian fossils, occur here only beyond the limits of the Silurian strata.

Mr. Lonsdale also mentions the occurrence of small fragments of a coral not distinguishable from the ramose varieties of F. fibrosa, in the mountain limestone of Steeraways.

FAVOSITES *serialis*—(Portlock)—Plate XXII. A, fig. 6.

Stem round and very regular, branched; tubes close together in quincunx, so as to rise in spiral lines round the stem. The tubes are sometimes so arranged that their walls fall in unbroken lines, as in fig. 6 b, and they then appear rhombic; but sometimes the lines dividing the tubes are minutely zig-zag, and then the tubes are hexagonal. A fracture at one end of the specimen shows the tubes passing obliquely to the centre, but the internal structure is no further known. The lines between the rows of tubes should be more strongly marked than in the figure. This is a small but very beautiful species, ·1″ only in diameter; it has the aspect of a Millepore.

Locality—Wexford. *Hook Point:* shale on limestone. Contributed by Lieutenant James.

CYATHOPHYLLUM.—In the use of the generic name Cyathophyllum of Goldfuss, there still appears some uncertainty and confusion. By its author, Goldfuss, it was made to include part of the genus Turbinolia (Lamarck), the genus Hippurites, considered by De Blainville a bivalve of the order Rudistes, and the genus Acervularia (Schweigger), and was defined as a calcareous, free, or attached Polyparium, consisting of cup-shaped, laminated, star-like, polype cells, which either increase singly as inverted conical or turbinated bodies, or are aggregated together in layers, according as one or more young cells spring from the centre or margin of the preceding, and become united together. And in a note at page 244, he adds—"Since only a few species and varieties of this genus assume the characters of the genus Acervularia of Schweigger, the great remaining number cannot be made subordinate to that mere sub-genus. The characters of Cyathophyllum are besides, in all the species, so manifest, that the naturalist, who directs his attention more to essential characters than external resemblances, will not be readily induced to separate the simple from the aggregated cells of the same species, in order to refer the one to the genera Turbinolia and Anthophyllum, and the other to the genus Astrea." If, however, the mode of growth of the aggregated species be studied, (see the base of one reduced to one-third of its natural size, Plate XXIII., fig. 3 b,) the correctness of Goldfuss' opinion seems very doubtful; they form large hemispherical masses from one to two feet in diameter, preserving the general size of the cells in individual specimens, and not enlarging as in the simple turbinated species, nor have I ever seen, on exposed rocky surfaces covered with these rounded lumps, any specimen showing a gradation from the simple to the compound; hence, it is more reasonable to suppose that each state is due to an original peculiarity in the mode of growth. The simple being separated from the compound, it may be asked whether there is any sufficient distinction between the genera Cyathophyllum and Anthophyllum, both being restricted to simple laminated corals. Mr. Lonsdale, and he is followed by

Professor Phillips, proposes to restrict the name Cyathophyllum to such corals "as have distinct, broad, transverse phragmata in the central parts of their structure," producing an appearance like the chambers of a nautilus, and those without such phragmata would fall into the genera Turbinolia and Turbinolopsis, unless the further character of Anthophyllum, that "the margin of the terminal cell is expanded," be considered sufficiently important and distinctive to determine the genus. Of the compound species, M. Lonsdale, adopting the views of Ehrenberg, classes with Astrea those species in which reproduction appears to have been effected by a division of the larger star into smaller, and with Acervularia, those in which such division does not appear to have taken place; but it may be doubted whether such classification is practicable in fossil species, as the same specimen often exhibits the subdivision of large into smaller cells in one place, and the interposition of a small at the angles of the larger in another. This latter mode is not unfrequent, a small quadrangular cell truncating the angles of the adjacent large cells, (see fig. 3 a). Of the simple laminated corals, one species only occurs in the Tyrone Silurian schists, and of the compound none. In Great Britain, Turbinolopsis extends from the Caradoc sandstone to the Aymestry limestone, and again occurs in the Devonian system. Cyathophyllum extends from the Caradoc sandstone to the Wenlock limestone, and again occurs in the Devonian and Carboniferous systems, as Turbinolia fungites is a Cyathophyllum. Of compound, both Astrea and Acervularia occur in the Wenlock portions of the Upper Silurian strata, and Astrea in the Devonian and Carboniferous. In the Carboniferous system of Ireland, both simple and compound laminated corals are abundant, and the former occurs also in the chalk.

SILURIAN.

TURBINOLOPSIS *elongata ?*—Plate XXIV., fig. 9.

This resembles T. elongata (Phillips); but when the external surface is perfect, the transverse wrinkles are seen, and not the longitudinal striæ; it also resembles fig. 6, Plate XVI., of Lonsdale (Sil. Sys.)

Locality—Tyrone. *Desertcreat* schists.

TURBINOLIA *fibrosa*—(Portlock)—Plate XX., figs. 7 a, 7 b.

There is some difficulty in deciding the true nature of these bodies; they occur isolated, are convex, but being depressed have very fine fibrous laminæ, and a central depression. They are found both in relief and in impression; but no lamelliferous coral, of the terminal cups of which they could be casts, has as yet been discovered. They may possibly belong either to Fungia or Cyclolites.

Locality—Tyrone, *Desertcreat*; gritty schists; lower portions of the system.

CARBONIFEROUS.

The more perfect separation of the central or chambered portions from the marginal or laminated portion, and the small thickness of the laminated sheath, are the only definite characters by which the genus Amplexus can be kept distinct from Cyathophyllum; and as the importance of such characters is doubtful, Bronn cites under C. flexuosum the Amplexus coralloides (Sow.) as a doubtful synonym. Many of the specimens of the North of Ireland exhibit all the characters of C. flexuosum, and comparatively only few are found possessing the sharp angular bend represented by Sowerby and Phillips. I am inclined, therefore, to consider, them varieties of the one species, C. flexuosum.

CYATHOPHYLLUM *flexuosum*—(Goldfuss).

"Inverted, conical, almost cylindrical, elongated, generally with worm-like bendings; on the outside very distinctly striated longitudinally. The terminal cell funnel-shaped, with numerous laminæ, which are thin, and equal."

It is given by Goldfuss as an Eifel fossil, but corresponds in its characters exactly with ours, which are nearly cylindrical, possessing, when large, the same thickness for a considerable distance. The surface is longitudinally striated, but transversely comparatively smooth, and bends much in the undulated way of a large worm. The laminæ occupy a larger space than in the typical Amplexus.

Locality—Sligo, *Kilvarnet.*

Of the more ordinary turbinated corals, there seem to be several species, though it is difficult to distinguish those of small size from the young of Turbinolia fungites. Goldfuss figures several variations of form under the name of Cyathophyllum ceratites, describing the figure as "inverted conical, bent at the base like a horn, the younger being externally nearly smooth, with only faint longitudinal striæ; the older and larger distinctly striated longitudinally, and marked by swollen transverse annulations; at the end the margin of the proliferous cells appears free. The rim of the terminal cell projects, and the lamellæ are numerous, equal, and somewhat curved." Hisinger refers those corresponding to the first part of the description to Turbinolia turbinata, and to Turbinolia mitrata; and retains those corresponding to the last, or such as have the uneven waved surface and the proliferous cell, as Cyathophyllum ceratites. Professor Phillips also remarks (Palæozoic fossils, page 3), that, on comparing specimens of Turbinolopsis with "very young specimens of one of several corals, often confounded under the title of Turbinolia fungites, and occurring in the mountain limestone, there is no appreciable generic difference. In old specimens horizontal septa appear, and this is perhaps not the case in Turbinolopsis;" there is, therefore, much difficulty and doubt in respect to these fossils, both generically and specifically.

Several very distinct forms can be traced in the Irish specimens, such as:—

1. TURBINOLIA *turbinata*—(Hisinger).—Short ·9″, conical, slightly bent, like a small drinking horn; deeply excavated, with about forty unequal lamellæ, which appear nearly marginal. The external surface is quite smooth; Hisinger says "sub-striata." This may be the young of another species.

Locality—Benburb.

2. TURBINOLIA *turbinata*, var. *verrucosa*—(Hisinger).—The surface knotted, or tubercular.

Locality—Tyrone, *Stewartstown.*

3. TURBINOLIA *mitrata*—(Hisinger).—Short, 1·9″ long, conical, bent; the lamellæ much stronger, slightly bent, and twisted at the centre into an axis. This is not exhibited in Hisinger's figure, which has the cup perfect, but is seen in our specimen from the coral being fractured. Surface externally smooth, but, when decorticated, shows the edges of the lamellæ, which are not arranged in pairs, as in Turbinolopsis, but singly, having, however, as in that genus, small connecting threads, rather irregularly disposed, which give a cancellated appearance to the denuded surface. This species, therefore, approaches to Strombodes on one side, and Turbinolopsis on the other.

Locality—Benburb, in shale.

4. CYATHOPHYLLUM *vermiculare*—(Goldfuss).—These are specimens of small size, preserving a nearly cylindrical form, which commences at a short distance from the point; much twisted, and rudely annulated or waved transversely; or, as expressed by Goldfuss, "with knee-like rugæ." It is also marked by transverse lines.

Lonsdale cites this species as a synonym under Strombodes vermicularis; but though possibly it may not be a true Cyathophyllum, our specimens do not afford any evidence for placing it in Strombodes.

Locality—Benburb, in shale.

5. CYATHOPHYLLUM *ceratites*—(Hisinger); C. *ceratites*—(Goldfuss,

in part). Here the coral rapidly expands from the base into a globose cup, but is again (in some specimens) contracted. The proliferous cell springs from the centre, and has a free margin. This is a young condition of the next species, the first stage of its growth being a wide, short, open cone.

Locality—Tyrone, *Derryloran*, *Clonoe*.

5. CYATHOPHYLLUM *fungites*; TURBINOLIA *fungites*. This large coral is from two to three inches in diameter, and from one to two feet long; begins conical, but quickly attains its full size, and is then nearly cylindrical, or often flattened into an oval section. It is irregularly bent, and has a very rugose surface. The transverse septa are very well marked. It is one of the most characteristic fossils of the Carboniferous epoch.

Locality—Fermanagh. Tyrone, *Carnteel*. Donaghmore, *Clonoe*.

ASTRÆA *hexagona ?*—Plate XXIII., fig. 1.

Cells sometimes pentagonal, sometimes hexagonal, variable as to depth, the lateral surface being in some more flattened than in others, and in all there is a further central furrow, which is either oval or round; has an oval flat umbo in the centre; interstices thin and sharp, sometimes obscurely crenulated, the crenulation occasionally becoming irregular tuberculations. This character, however, appears to depend on the accidental prolongations of the lamellæ up the edges of the interstices, and cannot be considered one of much weight. Laminæ varying up to 60; alternately large and small, though it is often difficult to discover the difference excepting in the cup; and hence it is very probable that the laminæ were not actually equal in Goldfuss' species. Some of the laminæ appear granulated on their edges, and they pass up the flattened faces of the umbo like fine threads. The general form of this very handsome species so closely resembles Goldfuss' figure of Cyathophyllum hexagonum, that, notwithstanding the supposed equality of the laminæ in that species, an appearance very deceptive as already remarked, I consider it the same, as it has the thin sharp interstices Goldfuss describes. The flattened oval umbo distinguishes it from Phillips' species, in which the umbo is conical and twisted. This appears to be the cellular surface of A. basaltiformis, (see that species).

Localities—Derry, *Desertmartin*. Sheet 41, No. 34. *Kilcronaghan*, sheet 41, No. 33: dark gritty limestone.

ASTRÆA *hexagona*, smaller var.—Plate XXIII., fig. 2.

Smaller than the last, but of the same general form; interstices thin and sharp, with very little trace of crenulation; cells deep, and a minute flattened oval umbo in the centre of the cup. Number of laminæ about 40, alternately larger and smaller, the alternations being more distinct than in the preceding.

Locality—Tyrone, *Clonoe* parish, in considerable mass; also Sheet 64, No. 10, siliceous limestone.

ASTRÆA *irregularis.*—Plate XXIII., 3 a.

Cells very irregular, hexagonal, pentagonal, &c.; interstices thin and sharp, and sometimes distinctly undulated, though not with the regularity ascribed by Phillips to A. pentagona; the laminæ in this species sometimes alternating with those on the opposite side of an interstice, sometimes meeting them; cells deep, with very little lateral flattening, and small, nearly conical umbo; sometimes the cells are flatter, then approximating to C. ananas, Goldfuss; laminæ about 40, often apparently of the same length, but sometimes unequal, or rather some are stronger than others. Fig. 3 b, reduced to one-third linear, shows the curious appearance of the base and mode of growth, as also the section fig. 3 c. It formed large masses, the one here figured being eight inches in length; others much larger. In portions of some specimens, where young cells have filled up the space of larger, and the surface has been worn, the appearance is exactly the same as in Goldfuss' figure of Cyathophyllum pentagonum, viz., a nearly flat surface, with a knob in the centre of each star.

Localities—Tyrone, *Kildress*, in red earthy limestone; Fermanagh, near Kesh, in large masses, exposed from the wear of the shales.

ASTRÆA *irregularis*, smaller var.—Plate XXIII., fig. 4.

Very small variety, in which the cells are deep, as in the preceding, but still smaller; there is the same, or greater irregularity in the number of sides.

Locality—Tyrone, *Clogher.* Sheet 64, No. 10; siliceous limestone.

ASTRÆA *basaltiformis.* CYATHOPHYLLUM *basaltiformis*—(Phillips). COLUMNARIA *sulcata*—(Goldf.) LITHOSTROTION *striatum*—(Flem.)

In this species the mass is readily fractured, and the long, slightly undulating, prismatic tubes look like basaltic columns in miniature. They are transversely undulated, and striated by waved longitudinal lines; but though, in this state, very peculiar and distinctive, they are, in fact, the columns of A. hexagona.

Localities—Tyrone, *Derryloran* parish, Clare townland; *Carnteel* in several places, in the same description of white siliceous limestone, which appears, therefore, to be a well characterized bed.

The genus Lithodendron was established by Schweigger, (Beobachtungen, 1819), who placed in it the genus Oculina of Lamarck, and part of the genus Caryophyllia, the remaining portion of Caryophyllia being formed into another new genus Anthophyllum, and in this arrangement he has been followed by Goldfuss. De Blainville makes Lithodendron a subdivision of the genus Caryophyllia, embracing the fasciculated species. In a geological sense, this restricted genus has not been carried downwards into the Silurian strata, nor does it appear in Professor Phillips' Devonian fossils. In the Carboniferous system it is abundant, and therefore valuable as one of the characteristic fossils of the formation. Professor Phillips notes its occurrence in the Lower Scar and Yoredale limestones. In Ireland it has not, as yet, been traced upwards into the newer formations. Of the original genus Caryophyllia, one species, C. Smithii, is dredged up, though very rarely, on the northern coast. From the vagueness of some of the descriptions of species, it is very difficult to identify those meant by their describers, more especially as, in some cases, enough of the specimen is not given to show the mode of growth. This is remarkably the case in the Caryophyllia fasciculata of Fleming, which is described as "crowded, branched, round, nearly cylindrical, slightly flexuous, and about a quarter of an inch in diameter," the specific name being adopted by Phillips, in his Lithodendron fasciculatum. For illustrations of this species, Fleming quotes Parkinson (Plate VI., fig. 8), and Martin's Madrepora cespitosa (Plate XVII.); but a comparison of these figures must render the identity of Parkinson's and Martin's species very doubtful. In Parkinson's, the branches, or rather the stems, as there is very little branching, are closely aggregated together, and slightly flexuous, bending together in one mass; whereas in Martin's figure they are represented as only in some parts coalescent, are more branched, very flexuous, and, as it were, by twisting one within the other, matted together. It seems, therefore, almost certain that these figures apply to different species. Phillips, again, has another species, Lithodendron sociale, which exhibits a similar character, the tube being "often adherent;" but the figure is not sufficient to show the exact character of the growth: as a synonym, however, Martin's Madrepora duplicata is cited as having some analogy with it, and that species is described and represented by Martin as being aggregated; hence, in that respect, agreeing with Parkinson's. In seems, therefore, necessary to reconsider some of these species in respect to their synonyms.

LITHODENDRON *fasciculatum*—Parkinson's figure, not Martin's, Fleming's, but probably not Phillips' species.

Tubes very crowded, so as to form a close mass; rarely branched, round, nearly cylindrical, flexuous, transversely striated, and about a quarter of an inch in diameter. Some specimens exhibit the same bending of the mass of tubes which is so evident in Parkinson's figure. This would belong to the sub-genus Calamophyllia.

Locality—Desertmartin. Sheet 41, No. 34; dark limestone, or rather shale, as the tubes are free from mixture. They are filled with a sparry limestone.

LITHODENDRON (Calamophyllia) *coarctatum*.—Plate XXIII., fig. 5.

Tubes very much crowded, and nearly simple; very small, being only ·1″ in diameter. The laminæ are fewer than in the last, being about 16. In some specimens the tubes are much more twisted and confused than in others; they are nearly smooth, though there are faint traces of transverse striæ, and by being pressed together they sometimes become angular.

Localities—Derryloran, Cookstown. Pinkish or reddish limestone; much ochreous matter. Between the two last there appears an intermediate species in Donaghenry parish, Anaghone townland, and this mode of growth should be made the distinguishing character of a subdivision.

LITHODENDRON *sociale*—(Phillips).
MADREPORA *duplicata ?*—(Martin).

"Tubes often adherent, equally striated, transversely undulated; lamellæ 64, alternately shorter and longer; axis oval (it is more or less so, the character becoming evanescent.) The size of the tubes is variable, from a quarter to more than half of an inch. I understand, by Professor Phillips' description, that the tubes are in general separate, but at intervals, and frequently bend towards each other, and adhere. This is not stated in the characters of Martin's M. duplicata, which, therefore, is not a certain though probable synonym.

The spaces between the tubes is much greater in the small than in the large varieties, and it is probable, therefore, that there are at least, two species, which should be grouped together in a subdivision founded on this mode of union, as distinguished from the cespitose species.

Localities—Derryloran, Clare townland; in very ochreous limestone; both the large and small varieties.

LITHODENDRON *irregulare*—(Phillips).

Classed with this species on account of its confused, irregular mode of growth; the nature of the laminæ not determinable from the specimens.

Localities—Desertcreat. Sheet 28, No. 105; dark earthy limestone.

LITHODENDRON *longiconicum*—(Phillips).

The terminal cups are very deep, the depth being equal to the diameter, and there is a flattened umbo, as in Astræa hexagona. The number of lamellæ is considerably less than in Phillips'; but it is probable the number varies with the size, and this is smaller, about ·3 of an inch diameter; surface smooth, which, however, is a distinction not sufficiently characteristic to separate it from L. sociale.

Locality—Derry, *Kilcronaghan*, sheet 41, No. 33; grey limestone, weathering gritty, and light coloured, much like that of Fermanagh.

The importance of a correct estimation of the characters of these species is considerable, as they are not always found in the same beds, and may, therefore, materially assist in the subdivision of the Carboniferous strata. This difference is sometimes very striking, a lower bed, principally composed of large masses of L. sociale, being surmounted by another composed of L. fasciculatum, the line of separation being quite abrupt; a sudden change, which it is difficult to conceive could occur without an abrupt stoppage of the growth of the first coral, an interval of time without any growth, and then the renewed coralline growth in another species; but how these alternations were effected can only be conjectured, though it would seem probable that, through some internal movements, the rocky surface was alternately abandoned and covered by the ancient sea.

The genus Syringopora is recorded in the Silurian system as occurring in the Wenlock limestone; in the Carboniferous system Professor Phillips has not found it above the Lower Scar limestone. In some portions of the Irish Carboniferous strata it is abundant, and may be studied, as it were, in the very mode and progress of its growth. On the flat, tabular limestone which forms the shore of Lough Erne, at Crevinish, near Kesh, the wear of the superincumbent shale has left exposed a vast quantity of corals in their natural positions, and amongst them numerous rounded masses of Syringopora. These show that the tubes were spread out at the base, and inclined inwards at the top, so that the reproduction would appear to have proceeded laterally. Three species are clearly distinguishable.

SYRINGOPORA *geniculata*—(Phillips)—Plate XXII., fig. 6.

"Tubes flexuous, round, radiating (an uncertain character, as it depends on position), and united by very numerous small, transverse, subverticillate tubules." Parkinson's figure of this species is excellent, showing the knotted or geniculated appearance it acquires from the numerous tubules, and slight bendings occurring at them.

Localities—Tyrone, *Derryloran*, *Errigal-Keerogue.* Grey limestone, weathering ferruginous. Fermanagh, exposed by removal of shale, in large rounded lumps, at Crevinish, near Kesh.

SYRINGOPORA *reticulata*—(Goldfuss)—Plate XXII., fig. 7.

"Small parallel tubes, connected by tubules, alternating at regular distances," (Phillips). The distance between the tubes is less than in Goldfuss' figure, but there is the same approach to regularity. Goldfuss describes it—"Tubes sub-flexuous, parallel, or diverging; connecting tubules sub-alternating. The tubes are of the thickness of a straw, are slightly undulated, parallel, or diverging, and are nearer together than in S. ramulosa. The connecting tubules are half as thick as the vertical tubes, and alternate, but not quite regularly." Martin's figure of Tubiporites catenatus is correctly cited by Phillips, but it is very doubtful whether the S. reticulata of the "Silurian System" can be referred to this species; it appears, indeed, so deficient in the regularity of the species, that it may be safely rejected, and the species be still considered one peculiar to the Carboniferous epoch. Goldfuss cites, I think correctly, Parkinson's figure of Tubipora strues, Vol. ii., Plate II., fig. 1.

Localities—Tyrone, *Clogher*, *West Longfield.*

SYRINGOPORA *ramulosa*—(Goldfuss).

Well distinguished from the preceding by the greater distance of the primary tubes, and the scattered arrangement of the connecting tubules. The tubes are thicker in Goldfuss' examples than in Phillips', the latter agreeing with the Irish specimens.

Localities—Derry, *Kilcronaghan,* Sheet 41, No. 33; grey, close-grained limestone, weathering white and gritty. Tyrone, *Clogher.*

SYRINGOPORA? *laxa*—(Phillips).

"Very loosely branched, variously coalescing, with few or no connecting tubules." This species deviates very widely from the ordinary type. Professor Phillips' locality is Ash Fell, Derbyshire.

Locality—Fermanagh, *Enniskillen,* dark grey limestone, weathering white and gritty.

Associated with Astræa, Lithodendron, and Syringopora, at the Crevinish locality, in Fermanagh, there occurs in abundance a coral composed of prismatic tubes, five and six sided, which are generally empty. The base, when seen, has that woody fungus appearance represented by Goldfuss in his figure of Manon favosum, (Pet. Pl. I., figs. 11 a, 11 b), in which the tubes also appear empty. Goldfuss subsequently transferred the species to his Cyathophyllum quadrigeminum, having originally hinted the propriety of doing so. Taking, however, Astræa basaltiformis as the type of C. quadrigeminum, the Irish species cannot belong to it, as portions of the internal structure, occasionally found, exhibit a mode of growth which more resembles Strombodes pentagonum of Goldfuss. It appears to have been proliferous from the centre, and in a section of a better preserved specimen there are successive, deep, inverted cones or cups, filling the tubes, and uniting at their margins into a continuous layer. The tubes are large, and I shall provisionally call the species Strombodes favosum. May not Phillip's Calamopora megastoma be the first stage of this species.

Localities—Tyrone, Fermanagh.

This remarkable assemblage of laminated corals, taken together, constitutes a well marked band in the Carboniferous system, whilst some of the species, as Astrea basaltiformis, characterize beds of limited vertical, though of considerable lateral extension.

There are a few other corals, both Silurian and Carboniferous, which require to be briefly noticed.

SILURIAN.

PTILODICTYA—(Lonsdale).

"Generic characters.—Thin, elongated expansions, having on each surface small quadrangular cells, not convex, which penetrate the coral obliquely, and are arranged, with respect to the surface, along the middle of the specimen parallel to the elongated direction of the coral, but on the sides obliquely from it. Surface; a very thin calcareous crust, traversed by slightly raised ridges marking the boundaries of the cells; towards the margin the crust thickens, the indications of the cells are less distinct, and the edges are invisible; but cells are traceable close to the margin, where the crust has been removed; opening of the cells small, transversely oval; no indication of a central partition parallel to the surface."

PTILODICTYA *dichotoma*—(Portlock)—Plate XXI., fig. 3 a.

Small fragments of this coral, from ·25″ to ·5″ long, lie confusedly together on one specimen: they are all, even in so short a length, dichotomous, like the magnified figure 6 b, and if put together would form a body resembling fig. 6 a. On one side of the flat, narrow expansion, the central line, or rib, forms a kind of keel; the other side is quite flat, so that the frond is thicker in the middle than at the sides; the keel is not shown in the large figure, the best preserved specimen having been found since it was drawn. Small quadrangular cells, arranged as described by Mr. Lonsdale, their obliquity at the sides producing a feathered edge, which can be seen even in fig. 3 a. They are frequently covered with a white calcareous crust, and when highly magnified, the specimens exhibit all the appearances detailed by Mr. Lonsdale. Fig. 6 a represents a large ramose specimen, but it is little more than an impression; and in the small fragment of the coral, still remaining, magnified in fig. 6 b, the obliquity of the lateral cells was not apparent, and the two faces appeared equally, though very flatly curved: this, therefore, may not be the same species, although strikingly like it in mode of growth.

Locality—Tyrone; *Desertcreat* schists.

Millepora *repens*, is common in the Tramore (Waterford) schists, but not found in those of Desertcreat.

CARBONIFEROUS.

VINCULARIA *multangularis*—(Portlock)—Plate XXII. A, figs. 7 a, 7 b.

Stem rounded, branched, and flattened, with about twelve furrows, in which are oval cells arranged in quincunx. As the furrows occur all round the stem, it differs from Flustra parallela (Phillips), though much like it.

Locality—This fossil has at present been only found in the dark smooth-fractured limestone of Dungannon and Drumglass, and is, therefore, characteristic of a particular bed. It is associated with Pecten *interstitialis*.

GLAUCONOME.

A more robust species than Retepora pluma (Phillips), more regular than G. disticha.

Localities—Drumglass, associated with the preceding: Benburb.

RETEPORA *membranacea ?*—(Phillips).

Another remarkable coral occurs in the shales of the parish of Clogher, County of Tyrone, Sheet 59, No. 60; the depressions or furrows are very slight, and are occupied by raised oval cells arranged in parallel rows; this is a flat expansion, and the raised oval spaces are probably casts of the fenestrules.

CELLEPORA *favosa ?*—(Goldfuss).

An incrusting species, much resembling Phillips' C. dentifera in the minuteness of the cells, but not exhibiting the spicular edges, occurs at the Hook, Wexford; it probably belongs to the species thus described by Goldfuss, "incrusting, forms a coating on many corals of the transition strata, and consists of small, depressed cells lying close together in irregular rows; they have raised rounded ostiola."

Plate XXII. A, fig. 8 a; portion magnified, fig. 8 b.

This little branched coral has a striking resemblance to Goldfuss' figure of Lithodendron gracile (Pet., Pl. XIII., fig. 2), a Quadersandstein fossil. It is longitudinally striated, or rather minutely furrowed, but without any traces of cells; the two spiral lines represented may be accidental. It is probably the striated side of a Glauconome.

Locality—The Hook.

The corals which have been here noticed are in number, including some strongly marked varieties, fifty-two; and if Turbinolia fungites, &c., were divided as has been suggested, and Amplexus admitted as a Cyathophyllum, the number would be fifty-six. They may be thus distributed:—

Silurian, exclusively, ...	19
Silurian, and in one locality of a more recent formation,	1
Carboniferous, ...	34 or 36

In respect to the distribution of the latter within the Carboniferous strata, an interesting fact, which will again be referred to when treating of the formation itself, may be noticed.

The Gorgoniæ and the Fenestellæ being at least assimilated to each other in their mode of growth and probable habitat, it might have been expected that the first favorable beds succeeding the Silurian strata, would have produced Fenestellæ, but such is not the case, as the lower shales are generally deficient in corals, and the example noted of their occurrence, is probably that of a Silurian species. This may reasonably excite a suspicion that some portion of the lower shales, &c., which have not as yet produced characteristic Carboniferous fossils, may really belong to the Devonian system. The Fenestellæ make their appearance after the deposit of a portion of the limestone; but their favorite habitat appears to have been the shaly deposits succeeding to the band of laminated corals. In respect to formations newer than the Carboniferous, the Lias has as yet in this country proved barren in Zoophyta, but the Cretaceous is rich in individuals, particularly of the genus Ventriculites of Mantell.

CRETACEOUS.

When the topographical proximity of the strata of the Carboniferous and Cretaceous systems in some parts of this district, and the small thickness of the intervening deposits are considered, as for example at Stewartstown, where the chalk is seen to have passed over the edges of the Carboniferous strata and to be only separated from them by a thickness of about 50 feet of new red sandstone (Pl. G., fig. 1), the great difference in their respective fossils becomes, as a geological fact, equally striking with that which has been noticed in respect to the Silurian and Carboniferous strata. In the former case the Crustacea afforded the most forcible illustration of the zoological individuality of the two periods; in the present one, the Zoophyta supply an illustration of equal force and beauty. Most of the forms before noticed have disappeared and have been replaced by the great family of the Sponges, although in the Caryophyllia centralis (Mantell,) there is still a representative of the laminated corals, and of the Favosites in Ceriopora and Heteropora, two genera, however, which are recorded, by Lonsdale, as occurring in the Silurian strata so low down as the Wenlock limestone, and by Goldfuss in the Eifel. In this district the chalk, as a whole, is most strongly marked out by its Zoophytes.

ACHILLEUM—(Schweigger).

In this genus of sponges the mass is composed of interwoven fibres, and there is a continuous external surface, by which it is distinguished from Manon in which there are several openings, or osteola.

ACHILLEUM *perreticulatum*—(Portlock).

Small, irregular, rounded lumps; sometimes rudely globular with a short neck of attachment. This in external appearance resembles A. glomeratum, but the fibres are more delicate and more regularly arranged in a distinct net-work than in that species. When preserved in flint the fibres are lost, and the surface exhibits the spaces between them in a neat though not quite regular reticulation, as they are lengthened out with sharp ends and rounded sides, like those of a partly closed net. In this state it peels off in layers, still showing the marks of the reticulating fibres.

Locality—Derry, *Dungiven*, in chalk; *Magilligan*, in flint.

VENTRICULITES *radiatus*—(Mantell).
SCYPHIA *Oeynhausii*—(Goldfuss).

Bronn and Goldfuss have united these as synonymous species, and from the descriptions given by those authors respectively, they are probably correct in so doing.

The general description of the genus is; when open, funnel-shaped, sponge-like bodies; formed, on the outside, of anastomosing, nearly cylindrical fibres which radiate from the base to the periphery, and form a more or less irregular net-work; and having the inside surface studded with small papillæ, which are perforated by minute tubes; when closed, they are elongated, conical, or nearly cylindrical, the external fibres becoming more nearly parallel, and the meshes of the network narrower and less regular. In this particular species the meshes of the external fibres have a tendency to an irregular obovate form, and are arranged also irregularly.

Locality—Derry, *Dungiven*, *Tamlaght*, &c.; occurring both in the distinctly white and in the green or lower chalk. The English locality is the white chalk of Lewes; and one of the foreign localities is "the hard greenish chalk of Darup, in Westphalia;" a curious coincidence in circumstances with the Irish localities.

VENTRICULITES *alternans*.
SCYPHIA *alternans*—(Roemer).

The longitudinal fibres of the external surface are nearly parallel, and anastomose in such a manner as to produce a net-work of tolerably regular oval meshes, which alternate with each other in the adjacent rows. One specimen in the cylindrical or contracted state displays this character very distinctly, the fibres being much wider apart than in the contracted specimens of the preceding species, and the meshes oval and regularly alternated.

Two internal casts also occur, which, as they exhibit corresponding differences, probably belonged to these species; the surface of one is covered with minute, slightly oval papillæ, and that of the other with papillæ of a much larger size and much wider apart. They appear to have been in a partially contracted or closed state, and as the papillæ, when they are open, project from the surface, it would seem that on closing the papillæ were contracted and became minute hollows in which, as moulds, were formed the papillæ on the surface of the casts.

Locality—Tamlaght.

SCYPHIA *tubulosa ?*—(Roemer).

Goldfuss includes the Ventriculites in his genus Scyphia, but there seems so very great a range of difference in the various species, that it is certainly desirable to retain, as is done by Bronn, the genus Ventriculites for such as group with the last two species. In this, the large anastomosing fibres forming a distinct net-work are no longer visible, but numerous rounded pores are irregularly disposed on the spongy surface; they are about ·1″ in diameter. The only specimen is imperfect and more cylindrical than Roemer's figure, and is, therefore, with hesitation ascribed to this species.

Locality—Derry, *Tamlaght.*

COSCINOPORA *infundibuliformis*—(Goldfuss).
SCYPHIA *infundibuliformis*—(Roemer).

The genus is defined as being "a cup-shaped polyparium, composed of compact straight bundles of fibres, arranged much more regularly than in the ordinary sponges; the upper surface with its regular funnel-shaped cavities, arranged in oblique rows, has the aspect of a cellepore, but the excavations pass entirely through the wall of the polypary. The species is described as either flattened or funnel-shaped, fixed to a root and pierced at the bottom; the openings or cells on both sides similar and square, narrowing inwards into fine tubes which passing through the wall end in fine pores at the other surface, on the elevated keel-like partitions which separate the square cells, so that the tubes of the opposite sides do not interfere with each other. From four to five inches in extent." This very beautiful Zoophite is easily distinguished by the regularity of the square openings on its surfaces, giving it the appearance, when in a flattened form, of a flustra, though in funnel-shaped specimens it cannot be mistaken.

Localities—Antrim, *Larne*, flattened; Derry, *Dungiven*, funnel-shaped; by Goldfuss, chalk marl of Coesfield in Westphalia.

HETEROPORA—(Blainville).

Separated from Ceriopora as having pores of two sizes, the small being scattered in the spaces between the larger.

HETEROPORA (CERIOPORA, Goldfuss) *cryptopora* (Goldf.) Var.

Bluntly lobed, and distinguished from Goldfuss' specimens by the larger size of the lobes which are ·5 of an inch in transverse diameter, and from ·5 to one inch in height above the principal mass. Goldfuss states that the surface is covered with very minute, round pores, or cells, having still finer pores, not distinguishable without a lens, between them. In this variety, from its larger size, the principal pores though very small can be readily distinguished; they are about ·017″ in diameter, and are separated by spaces equal to their diameter. The smaller pores are about one-fifth of the size of the larger and scattered irregularly in the spaces between them.

Locality—Derry, *Tamlaght;* chloritic or basal chalk.

SIPHONIA *cervicornis*—(Goldfuss).

This remarkable body is thus described by Goldfuss:—" Perfect specimens found in the chalk marl of Haldern have a stem sometimes long, sometimes short; cylindrical or inverted conical, straight or bent, and hollowed out into a funnel. The branches or roots, which spread out from the thinner end, are placed horizontally, branch two or three times, and are at their points often not more than a line thick." The roots of this body are not unfrequent, and there is one fine specimen of several branches spreading from a flat expansion, just at the point where the stem had commenced, and, therefore, similar to the one figured by Goldfuss. White chalk.

ECHINODERMATA.

Considering the Echinodermata as a distinct class they are of great interest, as having been represented in the whole range of the Fossiliferous strata, from the base of the Llandeilo flags (Note by Mr. Murchison, Sil. Sys., page 710) and upper Cambrian (Sil. Sys., page 671), to the most recent strata. In Ireland they commence in the Silurian strata, but are there rare; are abundant in particular portions of the Carboniferous strata; occur in the Lias, and are abundant in the Chalk. Beginning with the Crinoids; though fragments of the columns (Plate XV., fig. 2) are not unfrequent in a particular part of the lower portion of the Tyrone schists, two specimens only have been found of the body of a crinoid (fig. 1), which appears to belong to an undescribed species if not genus.

Plate XV., fig. 1.—Something of the form of this Encrinite is seen in the Plicatocrinus of Munster (Beiträge, 1839, Taf. XI., fig. 5, 6). Munster states that he was unable to discover any seam or division, which is also the case in these specimens, though when held in a favorable light faint traces are observed of a pentagon, each side of which is perpendicular to the apex of one of the small triangles which abut against the sub-pentangular centre. These triangles and the five costæ are very peculiar, and together distinguish it from any described species. Hisinger's Cyathocrinites? scrobiculatus, has similar triangular spaces, but they do not terminate as costæ. As it seems utterly impossible to force this species into any existing genus, I shall provisionally propose a name for it.

TROCHOCRINITES *lævis*—(Portlock)—Plate XV., fig. 1.

The base of attachment to the column was obscurely pentagonal, but there is no appearance of striæ; each side of the pentagon forms the base of a small triangle from the apex of which proceeds a rib. Distinct lines of subdivision cannot be discovered, though by holding the specimen in a favorable light faint traces are discovered of a circumscribing pentagon, the sides of which pass through the apices of the small triangles, and some also of another pentagon circumscribing the pentagonal base. The costæ and triangles are raised above the general surface which is quite smooth. Some of the costæ are bent at their junction with the triangles, and the whole specimen is slightly distorted. The wheel-like form is very peculiar.

Locality—Tyrone, *Desertcreat* schists.

Plate XV., fig. 2 a.

A crinoidal column abundant in the schists; the external surface is smooth and the joints regular; the section is oval (fig. 2 b) and the radiated portion occupies only a small space, leaving a large central cavity. The internal cast is, from its large size, very well preserved; the edges of successive joints in meeting form raised rings, which are grooved along their middle. This recalls to recollection Murchison's Pl. 18, fig. 2, in which the internal cast is also preserved, and his remark that it is characteristic of the Caradoc sandstone.

Locality—Tyrone, *Desertcreat* schists.

Plate XV., fig. 3.

This is probably an auxiliary arm, and is remarkable for the combination of small and large joints, in the manner of the columns of several crinoids; several small are interposed between the large which form distinct rings at regular intervals. It resembles Goldfuss' figure, (Plate VIII., fig. 7,) though only about one-fifth of its diameter, which is represented as a column and described as composed of " three low and small joints alternating with others higher and broader, through which arrangement the end of the column possessed an augmented power of moving, and could roll itself up in a spiral form;" a remarkable accordance with the specimen figured. See also an occasional form of the columnar joints in Actinocrinites 30-dactylus figured by Miller, Plate VI., fig. 12, 13. Goldfuss' locality is transition grits, and limestone of the Eifel.

Locality—Tyrone, *Desertcreat* schists.

CARBONIFEROUS.

MELOCRINITES (Goldfuss).

" Pelvic plates 4. First costals, hexagonal, 5. Second costals, hexagonal, 5. Intercostals, hexagonal, 5. Scapulæ, hexagonal, 5, placed on the costals. In respect to the relative succession and form of the plates this genus is closely allied to Actinocrinites, but is distinguished from it by the division of the pelvis into four parts, by a less number of costals and by the lateral position of the mouth."

I have quoted this description from Goldfuss, in order to point out that the next species to be here noticed cannot be placed in the genus Melocrinites of that author, although it is evidently the one he has described and figured under the name Melocrinites amphora (Nova Acta Acad., Naturæ Curiosorum, Tom. XIX., p. 341). By comparing his figure (Tab. XXXI., fig. 4 e) with his text, a remarkable contradiction will be immediately noticed; the number of first costals in the figure being *five* hexagonal and *one* pentagonal, as in the genus Actinocrinites; and this is not an error of delineation, as six costal plates of the same forms occur in the Irish specimens, (see our Plate XV., fig. 4 a), the draughtsman has, therefore, in this instance, corrected the error of description. The pelvis is in the figure, as in Actinocrites, hexagonal, whereas in Melocrinites it is pentagonal, the form of the pelvis necessarily corresponding to the number of costals; from which it is evident that this very beautiful Encrinite cannot be classed in the genus Melocrinites, as defined by Goldfuss. The division of the pelvis is into three equal parts by deep linear furrows, one of which is perpendicular to the base of the pentagonal costal plate. Goldfuss' artist represents a fourth faint line opposite the former; but on our specimens scarcely a trace of such a line can be discovered, and it was evidently not equivalent to the other, neither penetrating nor dividing the plate, and at the utmost an indication only of subdivision in the immature state. It is possible that this appearance of a line may have deceived Goldfuss, if he described the species from the figure, though it is surprising that he should have overlooked the number of the costals. The lateral position of the mouth, the five capital plates raised into knobs, and the knob at the base of the arm, are common to Goldfuss' and to our specimens. If the lateral position of the mouth be sufficient to mark generic difference this curious species should be removed from Actinocrinites but certainly not into Melocrinites; with the former it has more affinity than with the latter, and provisionally I shall restore to it the name originally proposed by Mr. Gilbertson.

ACTINOCRINITES *amphora*—(Gilbertson)—Plate XV., figs. 4, 5, 6.
A. *Gilbertsoni ?*—(Phillips). MELOCRONITES *amphora*—(Goldfuss).

Pelvis, hexagonal, and divided into three equal parts by furrows perpendicular to the base of three of the costals, one being the pentagonal costal. First costals, five hexagonal and one pentagonal. Second costals, five hexagonal resting on the hexagonal second costals. Intercostals hexagonal, and one between each pair of second costals (though with occasional irregularity as to form, produced by an anomalous position of the interscapular plate), excepting over the pentagonal costal where two irregular hexagonal, or sometimes heptagonal, plates are interposed between the second costals. The second costals are greatly diminished in height, the height being to the breadth only as 1 to 2. Scapula, pentagonal and very shallow. Interscapular plates irregular, hexagonal; two in the ordinary spaces, sometimes four of irregular form in the enlarged space. It may be observed that though Miller states the intercostals of A. triacontadactylus to be pentagonal, his generic figure of the various plates represents them, as they are found in this species, hexagonal, except over the pentagonal costals. The shallowness of the second costals and of the scapulæ, render the cup itself much more shallow than in A. 30-dactylus; and the arms, by the inclining over of the scapulæ, are brought so very low, that the interscapulæ fall in part between them. The arms are very thick, and surmounted at their base by a raised plate, forming a very prominent knob, fig. 5 a. Near the base of the proboscis is another knob-like plate surrounded by four other knob-plates, and by flat plates forming the base of the proboscis, though in the specimen figured it appeared smooth; all the other, or pectoral plates, are flat and, like those of the under surface, finely corrugated, the margin alone being striated (fig. 4 b). The proboscis is bulky and prominent (figs. 5 a, 5 b). It is altogether a remarkable and beautiful species. Fig. 6, is a monstrosity in which one arm is unnaturally developed in thickness, and the whole body elongated in that direction.

Locality—Fermanagh, *Cleenish*, townland of Tonyloman, Sheet 27, No. 24. Abundant in an ochreous decomposing bed of the limestone, the fossils being lined or filled with calcareous spar.

Plate XVI., figs. 1 a, 1 b.

The columns found in the same locality, though it cannot be said positively that they belong to this species, as they have never been found actually united to the body, are formed of nearly equal joints, which are usually smooth from wear, or, as in the figure, have a faint ring in the middle of each joint. The articulating margins of the joints are minutely crenulated.

The limestone is light coloured and very sparry, weathering ochreous, and the fossilizing matter highly crystalline.

ACTINOCRINITES *triacontadactylus*—(Miller).

Very fine specimens are abundant in the shale connected with the Hook limestone; the lateral third finger is quite distinct in these specimens, though it would be more correct to define it as a second hand ending in a single finger. The columns are found attached to the heads and exhibit all those variations in the alternations of large and small rings, noticed by Martin. Plate XVI., figs. 2, 7, 8, 9, represent some of them with their sections. The auxiliary arms have usually plain joints. Locality—Wexford: the *Hook*.

ACTINOCRINITES *icosidactylus*—Plate XV., fig. 7.

The difference between this species and A. 30-dactylus, if it be really a distinct species, consists in the arrangement of the hands. In A. 30-dactylus, from the upper edge of the arm plate on one side, proceeds the single lateral finger, and from the edge, on the other, the hand; and though the first cuneiform joint in each might have the appearance represented in our figure, those succeeding them are quite separate. In fig. 7 a, the two first joints from the arm plate are united, or dove-tailed together in the manner represented, and each alike perforated at the end, so that it is probable that this was the base of a broad hand dividing into two fingers, and without any lateral finger. The joints of the hand are wider and shallower than in A. 30-dactylus. Professor Phillips states that he had not observed in any of his specimens the lateral finger, which does certainly exist in A. 30-dactylus, hence it is probable that this is a distinct species, having only twenty fingers.

Locality—The *Hook*, County of Wexford.

ACTINOCRINITES *decadactylus ?*—(Goldfuss).

Pelvic plates deep and rugose. First costals, five regularly hexagonal, the sixth pentagonal. Second costals, irregularly hexagonal, and rather longer in a vertical than in a transverse direction, which is the reverse of A. 30-dactylus, and tends to lengthen the cup, which becomes more conical than usual. Scapulæ, some hexagonal, some heptagonal; all these plates are on the specimen examined, rugose; but where the margin has been preserved it is flat and striated, the general surface of the plate being convex and rugose. The greater elongation of the second costals distinguishes this species from A. 30-dactylus, and is a peculiarity represented very distinctly in Goldfuss' figure. Our specimen only extends to the arm plates, which are single, and were very probably surmounted by a single hand and finger as in Goldfuss' species.

Locality—Quarry near Stewartstown, County of Tyrone, limestone, weathering ochreous like that of Fermanagh. Goldfuss' locality is greywacke of Ems.

Portions of columns, ·75 of an inch in diameter, are common. In these the joints have a flat edge which is ornamented by a raised ridge or granulated ring. The granules are sometimes scattered irregularly on the rings. The alimentary canal is round. The scars of attachment of the auxiliary arms sometimes very large, sometimes oval, sometimes round.

Localities—Tyrone, Armagh, Fermanagh, &c.

RHODOCRINITES *verus*—(Miller).

Detached joints of a smooth-surfaced column have evidently belonged to this species. They have the Pentapetalons alimentary canal very finely marked; the striæ are strong, and do not extend inwards more than a quarter of the diameter, leaving a smooth central space around the pentapetalons canal.

Locality—Benburb, in shale.

CYATHOCRINITES ? *pinnatus*—(Goldfuss).

A portion of the column is all which has been obtained of this species. Goldfuss thus describes the joints—" The articulating surface of all the joints, with the exception of some which are pentagonal, exhibits a narrow, circular, alimentary canal, around which is a smooth annular depression, in the middle of which rises the alimentary tube like a small nipple. The striæ are regular, sharp, and strongly marked, the thickness of each being equal to the breadth of the furrows between them, and on the margin they are even stronger.

Locality—Fermanagh, ***Devenish.***

PLATYCRINITES *rugosus*—(Miller)—Plate XVI., figs. 3 and 13.

These are varieties of the same species. In the one, fig. 3, the surface has been more worn; but the rough tubercular appearance is still preserved, more especially resembling Miller's lower figure (17), where the tubercles run into each other. In fig. 13 there is a depression parallel to the outline of the scapular plates; and something of this kind may be observed in Phillips, but not in Miller's figure.

Locality—Fermanagh, ***Cleenish.***

PLATYCRINITES *granulatus*—(Miller)—Plate XVI., fig. 4.

This is the pelvis; it appears rounded from its position in the stone.

Locality—The ***Hook,*** Wexford; ***Portrane,*** Dublin.

PLATYCRINITES *lævis*—(Miller).

Locality—The Hook.

POTERIOCRINITES *conicus*—(Phillips)—Plate XVI., fig. 12.

Whether this is really different from P. tenuis of Miller, cannot be determined from this specimen; but the joints of the column seem considerably thicker than in Miller's figure, and I therefore refer it to the species of Phillips.

Locality—Fermanagh, ***Cleenish.***

Professor Phillips mentions two other species of this genus, P. granulosus, Belmore Mountain, near Enniskillen; P.? Egertoni, Florence Court.

GILBERTSOCRINUS—(Phillips).

Separated from Rhodocrinites, from which it very strongly differs, as may be judged from our figure in which more is seen than in that of Phillips. The point of attachment of the column is petaloid and very small. "Basal joints five, forming a pentagon, suprabasal five, hexagonal, forming a decagon with five re-entering angles, from which proceed five heptagonal first costals, and five hexagonal second costals, bearing a pentagonal scapula supporting joints. The specimen figured extends as far as the scapula, but it does not show the joints.

Gilbertsocrinus *simplex*.—Plate XVI., fig. 15.

The base is hollow, and there are no intermediate tubercles, by which it is distinguished from Phillips' G. calcaratus.

Locality—Fermanagh.

Pentremites *ovalis ?*—(Goldfuss).

"Four lines long, distinguished from all other known species by the convexity of the interambulacral spaces." Goldfuss also mentions that there is a tubercular rise at the point of the ambulacra, but it is not seen in our specimen, nor shown in Phillips' figure.

Locality—Sligo ? dark limestone. Phillips records it at Brushford, North Devon, and states that it is unknown as yet in the mountain limestone of England.

LIAS.—Pentacrinites *basaltiformis*.

Joints of the column. Locality—Magilligan ; Larne, in marl.

Of the Crinoids, the distribution of those which have been here noticed is—Silurian, one ; Carboniferous (including those mentioned by Professor Phillips), fourteen ; Lias, one.

The number as respects the Carboniferous epoch will, without doubt, be greatly increased when the strata of the Hook (Wexford), and of Fermanagh, Leitrim, Sligo, &c., have been fully examined. As an interesting fact, the great abundance of Actinocrinites 30-dactylus at the Hook, and the similar abundance of A. amphora in Fermanagh, may be mentioned, as illustrating the local distribution of these interesting objects, in which respect they correspond to the recent Pentacrinus, and Phytocrinus.

ECHINIDA.

None have as yet been found in the Silurian or Devonian strata of Great Britain or Ireland.

Carboniferous.—Though so rich in relics of animals of the crinoid type of this division of the animal kingdom, the Carboniferous epoch has hitherto appeared comparatively deficient in true Echinida. By Bronn (1837) they are represented as not descending below the new red sandstone, although the spines of two species of Cidaris had been described (not figured) by Professor Phillips (1836), and before him Ure (History of Rutherglen and East Kilbride, page 793) had figured the plate of one Cidaris, and the spine probably of another. Professor Phillips' description is, Cidaris vetusta, (Ph.,) the spine rudely muricated, Cidaris glabrispina, the spine smooth. Count Munster (Beit. 1839) describes the plates and spines of three species, and he observes "of the Sea-urchins which occur in the transition formation, neither perfect specimens nor exact descriptions are known to me." His specimens were from the productiferous limestone of Hof and Tournay, which Munster places in the Silurian system, and they consisted of plates, spines, teeth, and internal bones. Cidarites Nerei is thus described: "the plate has a round nipple disc; some small specimens are regularly hexagonal; the hemispherical nipple is pierced at the top, and surrounded by a prominent smooth ring, succeeded by a round smooth disc; the remaining portion of the hexagonal plate is finely granular. The large, long, almost cylindrical spines appear to be smooth, as it is only by a magnifier that very fine striæ are remarked. In Cidarites Protei the nipple disc is irregular, the nipple very small, and surrounded sometimes with a circle of lesser mammillæ, and sometimes by mammillæ irregularly disposed. The spines are small, narrow, and marked with short fine striæ, a portion of which end at the point in longitudinally arranged granules. In Cidarites priscus the plates are in form like those of C. Nerei; but the mammillæ on the surface are larger, and the spines have six granular ridges."

CIDARIS *Benburbensis*—(Portlock)—Plate XVI., fig. 10.

This species, though it has considerable resemblance to Count Munster's C. Nerei in the form of its plates, is strongly distinguished from it by its spines. Figs. 10 a and 10 b represent two plates: when perfect they are usually hexagonal, but with two sides elongated. The nipple is elevated, and surrounded by a strong circular ridge; external to this there is a raised thread-like line, which is sometimes concentric, as in 10 b, sometimes conformed to the external outline, as in 10 a, and from it radiate raised striæ, terminating in well marked granules or rugæ: even in the plates, therefore, it is sufficiently distinguished from Count Munster's species. Fig. 11 represents a plate from a Tyrone locality, differing considerably in form, being nearly a regular hexagon. The spines taper to a point, are long, frequently exceeding three inches, nearly round in section, though generally sufficiently flattened to produce faces. At the base there is a ring with a finely milled edge; for about half an inch there are no serratures; and thence to the point there are longitudinal lines, apparently six, of fine prickles, the prickles being closely set together, and alternating so as to produce the appearance of a spiral arrangement, see fig. 10 d; the surface seen by a magnifier is marked by very fine longitudinal striæ.

Ure's figure (Hist. Rutherglen, Pl. XVI., fig. 7) so strongly resembles the larger plates of this species, that it is very probable they are the same. The plates alone, however, are not sufficient for the determination of species; and if the smooth spines (fig. 8), found in the same localities, belong to the plates, which is, however, doubtful, the species might be Phillips' C. glabrispina. Ure's locality is Craiginglen, parish of Campsie.

Localities—*Benburb*, boundary of Armagh and Tyrone; Tyrone, *Clogher*, in shales. Sheet 65, No. 2.

CIDARIS *vetusta*—(Phillips).

General form of plate same as in last species, though varying as in fig. 11; no radiation from the central disc, the rugæ or granules forming a simple border, as in fig. 11, or sometimes covering a large space of the remote angles of the elongated space, by being arranged in a double row; ring at the base of the spine sharp, and more strongly milled than in Cidaris Benburbensis; spines tapering, three inches long, and having four, or sometimes perhaps more, rows of strong prickles. The prickles alternate, but are far more widely apart than in the last species, namely, in this ·19″, in that ·08″: and hence the spines have a less elegant appearance. No longitudinal striæ visible. In one specimen a considerable number of plates occur together, though crushed out of their exact position, and judging from them the species appears to have been large—probably three inches, at least, in diameter.

Locality—Tyrone, *Clogher*, in shale: Sheet 59, No. 62. Fermanagh, in shale: Sheet 28, No. 15.

In respect to the preceding species, the plates alone cannot be relied upon, as they vary considerably; but the spines are specifically characteristic. Some fine smooth spines, like productal spines, are mixed up with the others; they appear, however, to be solid, and also slightly enlarged at one end, and may, therefore, have also belonged to C. vetusta, or to some other species.

Taking into consideration the absence of true Echinida in the Silurian and Devonian systems of Great Britain and Ireland, so far as present research has gone, the spines and plates which have been here described become the more important, as marking a geological distinction in the shales which contain them, and affording another means of deciding the limits (downwards) of the Carboniferous system. In ascending to newer formations, the Oolitic system has, as yet, in Ireland, (Aghanloo *Ballyhanna*,) furnished only minute spines and fragments of the crust of an Echinus; but the Cretaceous makes up for the deficiency, by a considerable variety in genera and species, and by an extraordinary abundance of individuals. Some of these will be now figured and described.

CRETACEOUS.

ANANCHYTES.—Mouth on the inferior surface, and near the margin; anus also inferior, marginal, or near the margin, the one opposite the other; ambulacra complete.

ANANCHYTES *conoideus*—(Goldfuss)—Plate XVIII., fig. 1.

The principal characters which can be seized upon in the specimens are the blunt top and the straighter sides, by which it certainly diverges strongly from the next species. The sides either swell out from the base, which is, therefore, less than a section through a higher point, or rise straight up; the base itself is, however, nearly as flat as in the next species. These characters seem permanent.

Locality—Antrim, *Larne;* Derry, *Dungiven*.

ANANCHYTES *ovatus*—(Lamarck)—Plate XVIII., fig. 2.

The form of this species varies exceedingly, as it is sometimes much more conical than at others—a difference in part due to the different condition of the petrifaction.

It is remarkable that Agassiz considers Ananchytes ovatus a characteristic fossil of the upper portion of the chalk; but the species here considered A. ovatus, is common in the lower portion of the western Irish system, and Goldfuss also locates it in the Lower Chalk.

ANANCHYTES *ovatus*.—Plate XVII., fig. 3.

This is figured as showing the remarkable manner in which the pores are crowded together on approaching the base, where they seem to run into each other.

ANANCHYTES *sulcatus*—(Goldfuss).

"Base plano-convex, periphery obovate, hemispherical, with depressed summit; the chief characteristic distinction is the convexity of each row of the plates of the dorsal shell, in consequence of which the surface appears furrowed at the sutures, and the periphery of the base indented." This peculiarity and its more depressed form distinguish it from specimens of A. ovatus of the same size.

Localities—Derry, *Drumachose* and *Aghanloo; Dungiven*.

ANANCHYTES *pyramidatus*—(Portlock).

Some specimens are remarkable for their elevation, and for their acute summit. They appear to diverge too much in form to be considered as merely varieties of any of the preceding, and I give them, therefore, this provisional name.

Localities—various, in flint and chalk.

HOLASTER—(Agassiz).

Mouth at the anterior of the inferior face in a depression resulting from the convergence of the ambulacra to that point. The anus on the posterior face, and usually nearer the superior than the inferior face, and elliptic in a vertical direction. The ambulacra are complete.

HOLASTER *æqualis*—(Portlock)—Plate XVII., fig. 2.

I have so called this very pretty species from the equality of its length and breadth; the length appears to vary, probably from compression, unless there are two nearly allied species; the ovarial opening is narrow, and longer than wide. In the figured specimen it is distinctly behind the centre; in others nearly central, the latter being more elevated; and thus there are two characters of difference. The height to the length in the figured specimen is as 4 to 9. The form is cordate and elegant, gradually sloping or curving from the apex to the basal margin, which, though rounded, is rather sharply marked. It is closely related to H. Sandoz; but that species does not appear to have the sharp posterior keel or edge seen in this, and is more elevated; the keel, however, may be peculiar to the cast. Cast in flint.

HOLASTER *Sandoz ?*—(Agassiz) Var.—Plate XVII., fig. 1.

This is only a cast, but it resembles, in some respects, Agassiz' species; it is longer than wide, rounded and gibbous, giving it a blunter and less elegant appearance than the last; in the greenish marl or lower chalk, merging into greensand.

HOLASTER *planus*.
SPATANGUS *planus*—(Mantell).

"Ovate, vertex rather depressed, surface nearly smooth, dorsal (anterior) groove superficial, base slightly convex." Our specimens are all small, ·6″ long, and are identical in form with the small figures of Mantell (Plate XVII., figs. 22, 23), which he thinks are probably the young of his larger specimen; the anterior ambulacra are just visible in our best specimen. The characteristic peculiarity is the very shallow anterior groove, which is almost obsolete. It is rather an elevated species, particularly in the young state.

Locality—Derry, *Tamlaght.*

MICRASTER—(Agassiz).

One of the genera separated from the old genus Spatangus of Lamarck, from which it is distinguished by the ambulacra not being petaloid, but prolonged, though very faintly, to the lower surface. From Holaster it is distinguished by the ambulacra being depressed in furrows.

MICRASTER *cor-anguinum*—(Agassiz).
SPATANGUS *cor-anguinum*—(Mantell), Woodward?

Though agreeing in form and general characters with Agassiz' description, it differs in one important point. He states that the furrow (anterior furrow) extending along the front to the mouth is of medium breadth, but shallow, especially on approaching the mouth. The furrow, however, in the specimens figured by Parkinson, is deep; and in the Irish specimen, though shallow near the summit, it is deep on approaching the mouth. It is more truncated posteriorly than in Woodward's figure. Agassiz' locality is the Alpine, or Upper Chalk; Mantell's is also the Upper Chalk of Sussex.

Locality—Derry, *Magilligan,* filled with flint.

GALERITES—(Lamarck).

Mouth inferior, central; anus marginal, or infra-marginal; ambulacra complete.

GALERITES *vulgaris*—(Lamarck).—Plate XVIII., fig. 3.

Hemispherical, with a slight tendency to conical; the anus on the margin. Some are, as in the specimen figured, more oval and elongated than others, so that it is probable that a species approximating to G. Castanea (Agassiz) should be separated from the ordinary G. vulgaris.

Locality—Derry, *Dungiven,* &c.

GALERITES *albogalerus.*

Well distinguished by its pyramidal form from the preceding.

Locality—Derry, *Magilligan;* Antrim, *Glenarm.*

GALERITES *abbreviatus*—(Goldfuss).

This differs from G. vulgaris in being more depressed; the summit is flattened and rounded; the periphery of the base, as also the mouth, nearly circular. Only small specimens have been found, about ·5 of an inch in diameter, which are casts either in chalk or in flint; some from the interior are more depressed than those which have preserved a portion of the external crust.

Localities—Magilligan, in chalk flints; Balteagh, in the detritus.

GALERITES *sub-rotundus*, (Mantell,) young.

This is more elevated than the last, its height being nearly equal to its diameter. The periphery of the base is circular, and its margin so much rounded as to render the actual face very small; mouth nearly round. Mantell's figure shows that the periphery of the base is rounded inwards, though he speaks of the base as being flat; anus round, marginal.

Locality—Magilligan, in chalk flint.

Though these species approximate, by their circular form, to the genus Discoidea of Agassiz, the form of the anus is circular, and not oval.

CATOPYGUS—(Agassiz).

M. Agassiz remarks—"The genus Catopygus, such as I characterized it in my Prodromus, comprises all those species of Nucleolites which have an oval disc, the anus on the posterior face, and the ambulacra converging uniformly towards the summit. The study of a great number of species, then unknown to me, has since made me feel the necessity of more narrowly defining the genus, by taking the structure of the ambulacra into consideration; and in consequence I remove from the genus Catopygus all those species which have simple ambulacra, and refer them either to the genus Galerites, such, for example, as G. Castanea, or to the genus Pyrina, such as Nucleolites ovulum, retaining in Catopygus only those species which have petaloid ambulacra and the pores of the two ambulacral rows united by a groove, at the same time that those of the external row are lengthened transversely."

PYRINA?

The only specimens obtained are not sufficiently preserved to determine their exact generic position, but they seem to stand on the doubtful ground pointed out above. The form is oval and depressed; the height, breadth, and length, as ·37″, ·5″, ·69″; mouth in front of the centre; anus round, on the posterior face, and distinctly above the basal margin, but not in a sulcus, as in Nucleolites. The ambulacra do not appear to converge towards the periphery, and are probably simple;

hence the species resembles Nucleolites, and should be classed with Pyrina.

DIADEMA (Cidaris) *corollaris.*—Plate XVII., fig. 4.

(See especially Parkinson's and Mantell's figures.)

In Diadema the ambulacra are wide and tubercular; but in casts such as all there hitherto figured have been, the tubercles are merely smooth and depressed knobs, producing a surface, with very little inequality, as remarked by Mantell. The lines of pores (or rather the external one of each pair) are sinuous. Found in flints, and in the chloritic, or lower chalk.

CIDARIS? *vesiculosus*—(Goldfuss)—Plate XVIII., fig. 5.

(See Parkinson's figure cited by Goldfuss and Bronn).

Narrow ambulacra, and from four to five tubercles in each row on the interambulacra; mammillary space surrounded by tubercular granules, and the surface of the remaining crust covered with granules. The flattened barrel-shape of this species is remarkable. Part of the ovarial apparatus is preserved, but it is too imperfect for correct description. Lower chalk.

CIDARIS *acro-cidaris*—(Portlock)—Plate XVIII., fig. 4.

This pretty little species appears to form the type, in the peculiarity of the oviductal apparatus, of a new sub-genus, intermediate between Cidaris and Acro-cidaris. The ambulacra are narrow; the rows of granules close, and very slightly flexuous. The plates of the interambulacra large, and marked by lines or slight ridges parallel to their outline; the tubercles would, therefore, appear to rise from an angular base, but they are worn. The marked peculiarity is to be found in the oviductal plates. The ovarial are slightly notched by a triangular space opposite the termination of the ambulacra. The interovarial are truncated by a small hexagonal plate placed between it, the ovarial, and the suranal; this little plate resembles the central portion of the interambulacral plate, and has also a small tubercle. The suranal plate is, in this specimen, truncated, as if terminated by a central plate, and there are traces of lines subdividing it into divisions. It is evident, therefore, that, in the oviductal plates, this species approaches to Acro-cidaris, though the small tubercular plates are situated differently, and the ambulacra are also different.

ANNELIDA.—Of the tubicolous section of this class, species have been noticed in the strata of all formations; the genera Serpula and Spirorbis occurring in the upper Silurian strata, and having been thence uninterruptedly traced up to the existing epoch; but it was reserved for Mr. Murchison to discover relics of naked Annelides even in the Cambrian strata, and thus to afford another convincing proof of the necessity of caution in predicating the non-existence of any order, or even genus, of the animal kingdom in the most remote zoological periods. It is far from easy to determine what animals have been blotted out from the book of nature, within the existing period, as new research is every day adding new creatures to our lists; but it is impossible from collections made over spaces, which were merely specks on the ancient surface of the earth, to decide a question so important as that any one genus had no representative at any one given epoch. and we must expect to find all such decisions subject to reversal with the light of every new discovery.

SILURIAN.

Entobia—(Bronn).

This name was given by Bronn to those remarkable bodies found in the chalk, and first noticed by Parkinson.—(Org. Rem., Vol. 2, p. 75).—" They are small, round, compressed bodies, not exceeding an eighth of an inch in their largest diameters, and horizontally disposed, are connected by processes nearly of the fineness of a hair, which pass from different parts of each of these bodies, and are attached to the surrounding ones; the whole of these bodies being thus held in connection. That their formation has been the work of some animal of a nature similar to the polypes, by which the known zoophytes are formed, cannot, I think, be doubted. But in what genus in the order of zoophytes can they be admitted?" Such was Parkinson's opinion of them, and it was certainly a shrewd conjecture as to their origin. Subsequently they were again figured and described by Conybeare and Mantell, who adopted the opinion that they are siliceous casts of cavities, produced by boring Annelides which had excavated them in succession in the shells of Inocerami, the connecting fibres having been the passages from one cavity, when fully scooped out, to the place where the little animal commenced another. The extreme tenuity of the connecting threads as compared to the size of the cavities (or as they now appear, balls), is a difficulty in the way of this explanation; although the position they occupy in the space once filled by the substance of shells or by the sparry beak of Belemnites, renders it at least probable. It is remarkable that cavities of a very similar nature are found in the crusts of Trilobites, and in the substance of shells, in the Silurian schists, and I shall, therefore, adopt for them the generic name proposed by Bronn.

ENTOBIA *antiqua*—(Portlock)—Plate XXI., fig. 5 a.

This remarkable body is not unfrequent: it consists of small somewhat oval cavities in the crusts of Trilobites, which are connected together by fine lines or channels, in such a manner as to reticulate the surface in a very pretty manner. They are never filled up with solid matter as in the case of the chalk species. Fig. 5 b, is a magnified view of a small portion of 5 a.

Locality—General in the Silurian schists of Tyrone.

CRETACEOUS.

Nothing resembling the Entobia having been found in the intervening strata we arrive at once at the Cretaceous species.

ENTOBIA *cretacea.*

Several specimens have been found occupying the space which had been filled by the solid beak of Belemnites, the alveolus not having been attacked by them. This latter circumstance is sufficient to prove that the excavations must have been made in a solid body and subsequently filled up with siliceous matter; for, had the little balls and their connecting fibres been originally formed in hollow spaces, from which the Belemnite beak had been removed by decomposition, the chambers of the alveolus would have also contained them. The clusters of these minute spheroidal bodies connected together by spicula, or rigid threads, form a very beautiful fossil.

Locality—Magilligan, in chalk flints.

SILURIAN.

Of other Annelida the next affords an example in these ancient rocks of the genus Lumbricaria (Münster), which is stated by Goldfuss to occur only in the lithographic schists of the vicinity of Eichstadt. Goldfuss thus describes the supposed genus:—"These worm-like bodies have for a long time attracted the attention of naturalists, notwithstanding which their nature has not, as yet, been ascertained, nor their true place in the animal kingdom determined. Their worm-like form justified the opinion that they had belonged to worms, though no tubes like those of Serpulæ nor any traces of shelly matter had been discovered. They are never fixed to other bodies but lie free in the rocky mass. Their substance is usually a granular sparry limestone, and their outer surface is sometimes smooth, sometimes rough. They are seldom found single, but are usually twisted and coiled together in various ways. They might, it is true, be likened to the naked Annelides; but, as no trace of the opening of a mouth has been found, and no certainty acquired as to their true nature, it may be asked whether there are not reasons for supposing them inorganic bodies. To have secured the regular filling of such long tubes with petrifying matter, a skin would have been required sufficiently hard to resist the external pressure until the contained matter had itself become hard. If the skin had been thin and soft, the pressure of the liquid matter forcibly squeezed in, must have burst the tubes, and if it had been strong and thick like parchment, it must have left some trace behind it. It is, therefore, probable, that these worm-like bodies were not hollow tubes, but consisted of a solid mass. Taking also into consideration the fragments of various organic bodies, such as fish bones and joints of a small Comatula which sometimes fill them with a kind of bony conglomerate, is it not most probable (as Dr. Buckland has also suggested) that they were nothing else than the intestines of some marine animal? The name Lumbricaria may, however, be retained provisionally."

Though these reasons for the opinion adopted by Goldfuss are certainly forcible, and perhaps conclusive as regards the case noticed by Dr. Buckland, they cannot be considered decisive of the general question; for it is by no means certain, nor even probable, that the thin skin-like lining, secreted by some Annelides on the walls of their tubular excavations, would not be sufficient to preserve the form of the tubes until the petrifying matter had become hardened within them. That they are not squeezed in for some time during the life of the animal is certain, and it is, therefore, readily conceivable that they may have continued open for a much longer time. In the present instance their abundance, comparatively uniform size, and irregularity of arrangement render it almost certain that they were the work of Annelides on the sandy shore of the ancient Silurian sea.

LUMBRICARIA *antiqua*—(Portlock)—Plate XXIV., fig. 7.

Variously contorted; ·4″ in diameter; moderately smooth and transversely striated or obscurely corrugated. It differs from L. intestinum (Münster), by not being so much crowded together, and extending without interruption over a larger space.

Locality—Tyrone, *Desertcreat;* abundant on some of the slabs, but not on all.

The specimens are flattened and appear in relief, but cannot be separated uninjured from the matrix. The figure is reduced to one-half the natural size; some specimens are smaller.

LUMBRICARIA? *gregaria*—(Portlock).

On the surface of slabs which appear smooth and, as it were, glazed, are short tubulous impressions clustered irregularly together, as if they were either portions of longer tubes, or had been formed by many smaller Annelides working their way irregularly from a centre outwards. They are small, less than ·1″ in diameter, and associated with undefined knotty lumps, which strongly resemble the little heaps of castings from Annelides, so common on smooth sandy strands when the retiring tide has left them exposed.

Locality—Tyrone, *Desertcreat.*

APHRODITA ?—Plate XXIV., fig. 8.

These are fine spicula huddled together, which, from their resemblance to the spines of the Aphrodite or Sea Mouse, I am disposed to think have belonged to a small animal allied to that genus. As there are several clusters similar to each other, they cannot be explained as an accidental appearance of the stone itself.

Locality—Fermanagh; *Lisbellaw,* in Silurian schists.

CARBONIFEROUS.

SERPULA *socialis*—(Goldfuss)—Plate XXV., figs. 9 a, 9 b.

"Testa filiformi, elongata, lævi, laxa, pluribus in fasciculum aggregatis." "The long, thin, smooth, thread-like, almost straight tubes, loose or bent in all directions, are aggregated together and form bundles from two to four inches long and of the thickness of a finger. Individual tubes have a uniform thickness, though different bundles consist of thicker and thinner tubes."

The tubes in the specimen figured, are generally more rigid than those represented in Goldfuss' figure, and therefore agree better with his description, "almost straight tubes;" they are occasionally much bent, all in the bundle bending together. The thickness of the bundles is about ·4 of an inch, their length, visible on the specimen, four inches, and several bundles meet at the same point. Goldfuss cites Parkinson's figure and considers the species common to the Eifel or Devonian strata, the oolites, and the greensand; but it is probable that there were minute differences in the living animals of these very distinct epochs, and that of the Carboniferous epoch seems to have had its own peculiarity in the very rigid character of its bundles and tubes.

Locality—Tyrone, *Clogher;* in glossy bituminous-looking shale, associated with the spines of Cidaris vetusta.

SERPULA *sub-cincta*—(Portlock).

Tortuous, section round, beginning very small, but ·3″ in diameter at the larger end; has a smooth, shining, and very thin coating of a brown colour, which makes it very conspicuous in the white sparry limestone. It is marked with fine transverse elevated threads, which are so close together at the smaller portion of the tube as to become a fine annulation, approximating, therefore, to Goldfuss' S. epithonia, though the annulation is not so strong as in that species, or even visible without a magnifier ; at the larger end the lines are distant and irregular. This is described from two fragments in the same limestone and from the same locality, which, though now separated, were apparently parts of the same individual; the small fragment 1·1″, the large 2″ in length.

Locality—Armagh limestone ; light coloured and sparry. Contributed by Captain Jones, M.P.

SERPULA *sub-annulata*—(Portlock).
S. *epithonia ?*—(Goldfuss) Var.

Though not so strongly annulated as in Goldfuss' figure, this is more distinctly so than in the last species. It is small, ·06″ in diameter, preserves the same size, and is moderately tortuous.

Locality—Tyrone, *Killushiel.*

SPIRORBIS *omphalodes.*
SERPULA *omphalodes*—(Goldfuss).

" From the sudden increase of the last whorl these bodies, which are like minute Ammonites, ·12″ in diameter, appear usually to have only 2½ whorls. The somewhat compressed tube has an oval opening which is cut off quite straight. There are no transverse ribs or other markings."

Locality—Derry, *Maghera ;* in shales. They are fixed on the compressed stems of Calamites, and if removed, are found to have made a well marked impression on them ; they appear identical with Goldfuss' species.

SPIRORBIS *minuta*—(Portlock)—Plate XII., fig. 3 b.

These bodies resemble in general form the preceding species ; but are so minute and crowded together as to appear like a fine granulation on the crust of Dithyrocaris Colei. They do not exceed one-fifth of the diameter of S. omphalodes.

Locality—Tyrone, in shale.

OOLITIC ?

SERPULA *lævis* ?—(Goldfuss).

A curious brown marly bed at Dunseverick Mill-dam, County of Antrim, is traversed by the white calcareous tubes of these Annelides. The bed is probably part of the Oolitic strata, but requires further investigation as some of its fossils are peculiar to itself. The tubes appear to have been quite smooth and round, and are tortuous; they have no keel and resemble generally Goldfuss' S. lævis.

Locality—Tyrone, *Dunseverick.*

CRETACEOUS.

SERPULA *gordialis*—(Schlotheim). VAR. *serpentina*—(Goldfuss).

Goldfuss considers this as only a variety of S. gordialis, an oolitic fossil. It is a pretty species; the tubes being very delicate, and arranged like the coil of a rope, sometimes concentrically, and sometimes laterally in successive loops.

Locality—Magilligan.

SERPULA *gordialis.* VAR. *contorta*—(Portlock).

In this variety, the tubes are equally delicate; but they are not coiled on a plane as in the preceding variety, but are spirally contorted within the hollow occupied by the beak of a Belemnite. Being very fragile they readily break, and then look like pieces of curved springs. It is a very beautiful variety.

Locality—Magilligan.

SILURIAN.

CEPHALOPODA.—On entering upon the consideration of the Mollusca, I have selected this class as the first for illustration, as well from its importance and interest in a natural historical sense, as from its great geological range, which, under some of its varied forms, extends from the remotest up to the existing organic epoch. It is impossible, indeed, to contemplate this universality of the class, and to connect with it the abundance of species which at each change in the physical conditions of the earth's surface, arose to replace those of the preceding epoch, without feeling some surprise at the diminution the class has experienced, in some of its most important sections, in the existing period. The learned Ferusac has fully proved that the Nautilus pompilius, and Nauplius of the ancients, were the Argonauta Argo, or Paper Nautilus; and that the animal of the shell now called Nautilus, was, therefore, first made known by Rumphius, who discovering it at Amboyna, described and figured it in 1705. His figures representing the animal only in a contracted state, a very correct idea could scarcely be formed of its characters, and it was not till Mr. George Bennett had captured another in the New Hebrides, that an opportunity was afforded to Mr. Owen, to publish, in 1832, a detailed description of the anatomical and functional peculiarities of the animal and its shell. Little more than a century has, therefore, passed since a clue has been obtained to the true nature of the numerous cephalopodous remains which abound in the older strata, and up to that time they were necessarily objects of either popular wonder or of crude conjecture. The Nautiloid form of Conchiferous Cephalopodes, though still existing, may be traced back to the Carboniferous epoch, or according to Professor Phillips, to the Devonian, beyond which in Great Britain it appears to be replaced by the allied genus Clymene. Whilst, however, that one type has nearly spread over the whole range of organic periods, other genera which co-existed with, and even anticipated it, have long ceased to exist. Such is the case with the genus Orthoceras, which having been traced by Mr. Murchison back to the Caradoc sandstone, is abundant in the Silurian schists of Tyrone. The genus has recently been much restricted, more especially by Mr. Stokes, in applying the variations of the siphuncle as a principle of subdivision; but it will require still further modification, as it cannot even yet be affirmed that the first great line of division has been correctly drawn, namely, between those which were external and those which were internal shells, for some, without doubt, have been the one, and some the other. In those which were internal an approximation might have been expected to the Belemnitic type of Cephalopodes, but it has not hitherto been established; in the present work, however, it is hoped that the desideratum has been in some measure supplied in the structure of the Orthoceratites, figured Pl. XXVI., figs. 1, 2, 3, Pl. XXVII. fig. 1, and it is probable that not merely in these species, but in many others an external sac occupied the place of the Belemnitic beak. The same structure, with a spiral siphuncle, Pl. XXVIII. A, fig. 2 a, affords another singular modification of form, but these will be noticed in order, and I shall proceed, therefore, at once to the description of the Family of which the genus Orthoceras is a member.

ORTHOCERAS *calamiteum*—Plate XXV., figs. 1 a, 1 b.
ORTHOCERATITES *calamiteus*—(Münster)—Beiträge, 1839, P. 36, Plate 17, fig. 5.

In external characters this species agrees closely with Count Münster's description. "Annular projections, distant from each other two lines (Parisian measure) surround the shell. Strong longitudinal stripes (threads) pass over the projections without interruption and give to some specimens the appearance of Calamites approximatus. The longitudinal stripes are alternately strong and fine and are intersected by very fine transverse striæ lying close together." In the species here figured, there is not an exact alternation of strong and fine longitudinal lines, as the stronger have more than one fine line between them.

Professor Phillips, on the authority of M. A. Verneuil, has given this name as a synonym for O. tubicinella of Sowerby, but the accuracy of such determination may be doubted. In Count Münster's figure the annulations are not oblique as in O. tubicinella, but straightly transverse as in our figure, and as in our specimens, are marked by transverse lines, which together with the longitudinal, produce a reticulated surface : such transverse lines are not mentioned either by Sowerby or Phillips.

It is unfortunate that Count Münster does not mention the form of the section ; and his figure leaves a doubt whether it is, or is not elliptical. In the Irish species it is elliptical, the diameters being about as 1 to 2 ; but the form of the section in this, as in other annulated species, may have been modified by pressure. The tapering is extremely gradual, and the lines both longitudinal and transverse are raised thread-like ribs. In one specimen having a surface more than an inch across, the annulations are less elevated and the striæ finer. It is probable, therefore, that with increased growth the annulations would become still further depressed, or entirely cease; and the surface resemble strongly Orthoceras fimbriatum (Silurian System, Plate 13, fig. 20). In that species, however, the section is circular, whereas in this there is every reason to believe it elliptical. In one fine specimen the transverse striæ are not so strong, and the longitudinal striæ not all separated by finer striæ. This specimen shows an approximation to O. tubicinella.

Count Münster's specimens were from the upper layer of the transition limestone of the Fichtelgebirge, near Elbersreuth.

ORTHOCERAS *gracile*—Plate XXV., fig. 2.

This is related to the preceding by the gentle and rounded swell of the annulations ; but they are wider apart, the distance being nearly one-third of the diameter ; the thread-like ribs are also stronger and wider apart, and have no intermediate ribs ; the distance between them is about half of that of the annulations. The annulations are oblique and the septa appear to correspond to the hollows between them. Very little if at all tapering. Traces only of transverse lines.

ORTHOCERAS *tubicinella*—(Var. *sub-nodosum*)—Plate XXV., fig. 3.

This species approximates closely to Sowerby's O. tubicinella; it tapers, however, rapidly at the end, and the section, though the specimen has been partly crushed, was in all probability oval. Tapers rapidly; annulations oblique and sharp; distance between them .19″, crossed by strong thread-like ribs alternately strong and fine, as in Phillips' specimen, which intersecting the sharp edge of the annulations produce a sub-knotted appearance. Section elliptic?

O. *tubicinella*—(Var.) elliptic—Plate XXV., fig. 4.

The annulations are not quite so sharp, nor so oblique, and are a little more distant, but the character of the ribs is exactly the same; it appears probable, then, that this and fig. 3, may in reality constitute one species, closely allied to if not identical with O. tubicinella. If it be considered possible that the elliptic form which prevails in almost all the annulated species of these localities, be the result of that compression which in some degree they have certainly undergone, this species would at once fall into O. tubicinella; but if so, the fact that compression has taken place with no further fracture of the surface than longitudinal cracks along the sides, seems to indicate a constitution of the original covering differing from the unyielding nature of shell.—(See also O. rugosum, Phil. Geol. of York., p. 21, f. 16.) In very small specimens, one-fourth of an inch across, the intermediate longitudinal lines disappear, and they are then all of equal strength.

On the true nature of these bodies some doubt may be entertained; and in the "Memoir of Londonderry" the analogous O. calamiteum was represented as probably the siphuncle of an Orthoceras, an opinion which is supported by Plate XXVII., fig. 7, in which O. tubicinella appears to be internal to a loose sack-like sheath, such as will be further noticed in some of the succeeding species.

ORTHOCERAS *per-annulatum*.—Plate XXV., figs. 5, 6.

The fragments of this species are of considerable size, viz., six inches in length, and three inches in breadth; but they have suffered very great compression, the opposite surfaces being quite squeezed, or flattened together. The annulations are moderately sharp, and, in proportion to the breadth, closer together than in the other species. Fig. 5 is either a young individual, or a portion from near the pointed extremity, and the annulations are distant about one-sixth of the apparent diameter; whilst in fig. 6, reduced to one-half its natural size, the distance is not more than one-eleventh of the apparent diameter; they are rather irregular, and waved. The species appears to have tapered gradually, to have been more than twelve inches long, and probably elliptic in section. Nothing can be said of the siphuncle.

The variation in the proportion of the distance of the annulations to the diameter deserves remark; the distance does not increase proportionably to the growth of the shell, and appears, therefore, at different points relatively greater or less. This consideration renders it probable that O. Ibex and O. articulatum of Sowerby (Silurian Researches, Pl. V., figs. 30, 31), are the same.

ORTHOCERAS *sub-annularis*—(Münster)—Plate XXV., figs. 7, 8. (Beit., 1840. Taf. XIX., fig. 3.)

These are probably the same species. Fig. 7 from the schists of Desertcreat, Tyrone; Sheet 37, No. 6. Fig. 8 from those of Fermanagh; Sheet 27, No. 2. The annulations are very little raised, and distant about one-third of the diameter; the section slightly oval; siphuncle small and central; septa convex downwards, and in fig. 7 they correspond to the summit of each undulation. In fig. 8 the annulations appear finally to cease upwards, the shell tapering very gradually. On the surface of fig. 7 there appears a small ramifying coral, affording another case similar to those of Mr. Stokes and Mr. Stuchbury.

"Count Münster's description is—" Some fragments of my collection, in which the siphuncle is not distinguishable, approximate so closely to O. annulata of Sowerby, that I had at first connected them with it. The siphuncle is, however, central, not eccentric; the aperture circular, not compressed, and the rings are much flatter and nearer together." Count Münster notices also fine transverse striæ, as visible when the shell is preserved. The shell is gone in the present specimen, and such striæ are not perceptible. Münster's locality is Elbersreuth.

ORTHOCERAS *Brongniartii*—(Troost)—Plate XXVII., fig. 4.

Very slightly tapering; section oval; diameters nearly as one to two; siphuncle circular, about one-fourth of the longer axis in diameter: slightly eccentric in the line of the longer axis; septa numerous, distant from each other from one-seventh to one-sixth of the longer axis; concave upwards; convex downwards, and bending down to the siphuncle, so that, when broken below the junction, a ring appears like an outer siphuncle surrounding the true siphuncle. The outer crust or shell being entirely destroyed, the nature of the external markings cannot be determined, and from uneven wear an appearance of undulation, in the margin of the septa, is produced, which is due to the section cutting the raised portion of the septum within the actual margin. Length of the specimen, 7·5″; breadth in the middle about 2·75″; depth about 1·5″; distance between septa, ·44″.

Though this species, in its apparently undulated septa, has considerable external resemblance to Orthoceras undulatum (Sowerby), O. laterale (Phillips), it is distinguished from it by the different proportion of the axes, and by the magnitude of the siphuncle; and from O. imbricatum of Hisinger and Phillips by the different proportion of the axes, the magnitude of the siphuncle, and the greater distance of the septa. Count Münster, indeed, observes generally on the Orthoceratites of the transition limestone of the Fichtelgebirge—"All these Orthoceratites have narrow siphuncles, which, with one exception, are in the centre of the septum; at least, I have here found, as yet, no example of Orthoceratites, with large wide siphuncles, and still less with lateral or ventral siphuncles, such as are found in the mountain limestone Orthoceratites;" the present species is, however, a striking exception to the rule.

In the Mem. de la Societe Geologique de France, Vol. 3, pages 88, 89, Mr. G. Troost, Professor of Chemistry, Mineralogy, and Geology, at the University of Nashville, United States, proposes a new generic division of Orthoceratites, under the name Conotubularia, which is mainly distinguished by an annular tube or siphon, the internal cast of which, being generally all which remains, obtains from the people of the country the characteristic name of Rattle Snake Tails. No secondary tube within the siphuncle has been discovered, nor any subdivisions of it; hence, the genus is distinct from Ormoceras and Huronia of Stokes. The section is sometimes circular, sometimes oval; the septa bend up to the siphuncle, and a transverse section through them often appears waved. The siphuncle is large, occupying a considerable portion of the whole section. All the external characters here described, as well as the figure given by Mr. Troost of his second species, Conotubularia Brongniarti, (Pl. 9, fig. 2,) in which some of the septa appear straight and others waved, correspond so perfectly with those of our specimen, that there can be little doubt of their identity, although a longitudinal section is still required to demonstrate the annular character of the siphuncle.

Mr. Troost considers the limestone of the vicinity of Nashville which contains these fossils, to belong to the "upper transition system, or perhaps to the mountain limestone of English geologists." The Conotubulariæ are associated with Bellerophon hiulcus (Sow.), Orthoceratites simplex, Isotelus Dekayi, Stromatopora concentrica (Goldfuss), S. verrucosa (Troost), Catenipora labyrinthica (Goldfuss), Calamopora Gothlandica (Goldfuss), &c., Columnaria sulcata (Goldfuss), &c., Productus, Spirifer, Terebratula, &c., a mixture of fossils which deviates widely from the Silurian type, although, without a complete analysis of all the fossils, it would be impossible to decide whether it indicates or not an American Devonian system.

ORTHOCERAS *Pomeroense*.—Plate XXIV., fig. 4.

Fig. 4 represents, in the position in which they occur, two fragments of a large Orthoceratite, which together are seven inches in length and four inches wide; and fig. 5, the section of another flattened specimen of the same species, six inches long, and more than four inches wide. The surface is nearly smooth, being only marked by fine transverse lines (not raised thread-like striæ). Neither the position of the siphuncle, nor the distance of the septa, can be determined from these specimens; but it is probable, from an appearance of fracture in specimen 5, that the septa are very remote, probably two inches apart.

It is impossible to identify this with any described species; and provisionally, therefore, a distinct name has been given to it. Were the siphuncle visible, I should be inclined to associate it with O. Mocktreense of Murchison.

Locality—Tyrone, *Desertcreat* schists.

ORTHOCERAS *lineatum* (Hisinger)—Plate XXVII., figs. 3 a, 3 b; XXVIII., fig. 1.

Count Münster (Beit., 1840, pages 101, 102) describes several species having thread-like longitudinal striæ or lines. Hisinger (Lethea Suecica) had previously described a species of the same kind as Orthoceratites lineatus "shell cylindrico-conical, longitudinally and very finely striated; syphon central;" the O. striatus of Marklin as quoted by Hisinger. These differ from ridged species, such as O. Gesneri of Martin, the lines being arranged like fine threads on the surface as in Murchison's O. filosum. Between Hisinger's O. lineatus and Münster's O. tenui-striatus, there appears to be no very marked difference, more especially as some variation in the degree of fineness may be reasonably admitted as probable. In one specimen (Pl. XXVI., fig. 6) which is not unlike Martin's O. Gesneri (fig. 2, not fig. 1), the lines are strong, nearly amounting to ridges; but in Plate XXVII., fig. 3, the lines are very fine, or hair-like, agreeing with the O. lineatus (His.), or O. tenui-striatus (Münster). Count Münster's description is, "very much less conical than O. striato-punctatus; it has on the shell very fine hair-like striæ lying close together, which are only visible on the outer surface. It is rare, and hence neither the septa, nor the siphuncle, have as yet been discovered. From the black Clymenienkalk of Schübelhammer." In the specimen here referred to this species, the lines are very fine, or hair-like, the spaces between them being equal to about four times the thickness of the threads. It appears to have been very much elongated, and, though tolerably regular at the top, to have had lower down a loose gut-like appearance, whether original, or the result of pressure, cannot be determined. In one specimen there is an appearance of an external sheath, which is marked by transverse lines, and traversed by a siphuncular tube, similar to fig. 1. Of the septa little is known, though they may be occasionally traced, and are then approximate. When perceptible, they are moderately near to each other, as in Plate XXVIII., fig. 1: and in a specimen, which has not undergone pressure, the form is exactly the same as in the transversely lined species (Pl. XXVII., fig. 2), the septa lines agreeing with those of fig. 3; whilst longitudinal threads are observed on one part of the surface, and obscure traces of transverse striæ on another, leading to a doubt whether such markings may not be the result of impressions varying under different circumstances.

ORTHOCERAS *subcostatus*.—Plate XXVI., figs. 6 a, 6 b.

Differs from the preceding by stronger lines, which are wide apart, and irregular in size; they do not amount to ridges.

In the Min. Con. (Plate 588, fig. 3), Mr. Sowerby has figured and described under the name Orthocera cincta, a species "ornamented with numerous sharp annular striæ." Professor Phillips (Palæozoic Fossils, Plate 41, fig. 204, and Geol. Yorks., Pl. 21, fig. 1) refers to that species an Orthoceras, "the general figure of which is elongate; the surface girt with fine *undulated* raised lines; the section a short ellipse; the septa nearly direct, distant ·27, ·28, ·35 of the diameter, and deeply concave; siphuncle central, or very nearly so." A careful comparison, however, of the characters of these shells must raise a doubt of their identity, as the sharp annular striæ of Mr. Sowerby's figure exhibit no undulations, and have that rigid thread-like appearance which is so highly characteristic. Count Münster (Beit., 1840. Taf. XIX., fig. 4) has also an Orthoceratites cinctus, "the outer shell almost cylindrical, girt with fine, but sharp annular striæ, lying close together, and on the inner shell appearing but as fine lines. Locality—Elbersreuth." He also mentions a variety from the "Clymenienkalk" of Schübelhammer, with somewhat sharper and stronger striæ. The latter would perhaps agree better with Sowerby's figure, and Count Münster's first with our species, in which the striæ appear more delicate than in Sowerby's, though not quite so much so as in Münster's O. linearis.

ORTHOCERAS *tenui-cinctum*.

O. *cinctus*—(Münster). O. *cincta* ?—(Sowerby). Not O. *cinctum*—(Phillips).

This species, though nearly cylindrical in the upper portions, assumes, for about five inches towards its point, an elongated conical form, the last inch and a half or two inches being a small tube, probably the prolongation of the internal siphuncle into the external sac. It is marked by fine, but distinct, transverse, hair-like rings, seven of which occur in the space of one-tenth of an inch. When crushed in the centre longitudinally, which is very common, the striæ sometimes appear oblique. On impressions, the places of the striæ are marked by fine lines. Towards the point it is so similar in form to Pl. XXVI., fig. 2, Pl. XXVII., fig. 1, that it is unnecessary specially to figure it, more particularly as the septa are not perceptible in any of the specimens, though they occasionally occur grouped together in great abundance.

Hisinger's O. centralis does not appear to differ from Sowerby's O. cincta, both having had a circular section, whereas the section of Phillips' species was a short ellipse.

ORTHOCERAS *elongato-cinctum*. Plate XXVII., figs. 2 a, 2 b.

This species has even finer transverse striæ than the preceding; they are nearer together, and not quite so regular. It is a very cylindrical and elongated species, attaining, at five inches from the point, a diameter of about three-eighths of an inch, and it should be remembered that most of these species have their most rapid increase near the point. In fig. 2 b the septa are seen, the diameter being about equal to that of an ordinary goose-quill, and the septa less than half the diameter apart. How much higher the septa may have extended, it is impossible to say, nor can the position of the internal siphuncle be determined. In fig. 2 the probable termination is given from a specimen in which the transverse striæ are almost obliterated, and in that state of preservation it approximates to Count Münster's O. acuarius. This and the preceding may possibly merge into one by intervening gradations. In a Fermanagh specimen there are obscure traces of thread-like striæ, and in form also it agrees with this species.

ORTHOCERAS *sub-flexuosum*—(Münster)—Plate XXVIII., fig. 3.

Thus described by Münster—(Beit., 1840. Taf. XIX., fig. 9).—"Hitherto only found in small fragments, which are distinguished by a flattened elliptical form, undulating transverse striæ, and an eccentric siphuncle near the margin; septa very near together." The position of the siphuncle and the exact form cannot be determined from this specimen; but the septa are near together, and are crossed obliquely by the waved transverse striæ, which are even more waved than in the figure. This may possibly be Phillips' O. cinctum. Count Münster's locality is Elbersreuth.

ORTHOCERAS *sub-undulatum.*—Plate XXVIII., fig. 2.

This fragment differs from any of the preceding striated species, the striæ not being elevated as fine threads; hence, the surface is marked by depressed or cut lines, which, as well as the septa lines to which they are parallel, are very slightly undulated, and it is even difficult to distinguish the septa lines from the others, though they are a little more strongly marked. It is probably an internal cast, and nothing more can be determined respecting it from this, the only specimen. The undulation is so slight that I have given the name sub-undulatus to it. The parallelism of the septa lines and of the striæ is characteristic.

Whether the Orthoceratites figured in Plate XXVIII., figs. 5, 6, be really distinct from those already described, it is difficult to determine from the imperfect condition of their surface. It is, however, probable that they are so, as they preserve more generally a rounded section, and are irregularly flattened, so as to exhibit, at intervals, a swollen or tumid appearance. Provisionally, therefore, a name has been adopted for them.

ORTHOCERAS *tumidum*—(Portlock)—Plate XXVIII., figs. 5, 6.

Elongated, conical, irregularly swollen, the section at the swellings being circular, and flattened more or less in the intervals. The cause of this irregular swelling is unknown, though, as a probability, it may be sought in successive enlargements of the chambers, and an increased deposition of solid matter on the septa at those particular points, in consequence of which they are able to sustain a greater degree of pressure, and preserve their form when the intervening portions are crushed. Septa not distinct, but as well as can be traced, near the point ·25 of an inch apart, a distance not increasing proportionately with the growth of the animal, so that, near the point, the distance of the septa is equal to the diameter, and higher up equal to one-half, and so on. Siphuncle small, or tubular, and central; very little of the crust or external shell is preserved; it is transversely striated. The long specimen, fig. 1, is seven inches long, and one inch in diameter at the top. In one portion which shows no trace of an external shell, the surface is uneven.

Locality—Tyrone, *Desertcreat* schists.

ORTHOCERAS *brevi-conicum.*—Plate XXVIII., fig. 8.

Short, wide cone, the diameter being to the length as 5 to 6. Septa approximate, distance varying from one-tenth to one-eighth of an inch; position of siphuncle unknown. This, the only specimen, is unfortunately crushed on one side, as shown by the figures 8 b; the preserved side, is, however, circular in section, and has no longitudinal bend curve. This species forms even a shorter cone than Sowerby's O. conica (a Belemnite), Pl. 60, fig. 1, and much shorter than his fig. 2. Hisinger's O. conicus is a long sharp cone.

Locality—Tyrone, *Desertcreat* schists.

ORTHOCERAS *sub-arcuatum*. Plate XXVIII., fig. 9.

Curvature very slight, being almost evanescent on one side; septa approximate, the distance between them being one-eighth of an inch, extending to the top of the specimen, and above it, as seen by an impression in the matrix; the form, therefore, of the aperture unknown, as is also the position of the siphuncle. Section of the only specimen at top ovoid, being narrowed towards the external or arcuated margin; the section resembling, therefore, the longitudinal section of an egg. Length of specimen, a fragment, 1·75″; greatest diameter of the section, 1·75″; transverse diameter, 1″: it is, therefore, a short thick species. Some faint traces of transverse lines on the cast.

This species evidently rests on the border between Orthoceras and Cyrtoceras, and between Cyrtoceras and Phragmoceras, approaching also to Gomphoceras. The want of a full knowledge of the aperture must leave its position, in some degree, doubtful; it is analogous to P. arcuatum (Sil. Res., Pl. 10, fig. 1), but is very much less arched, and has much more approximate septa.

ORTHOCERAS *complanato-septum*—(Portlock)—Plate XXVIII. B, fig. 11.

Section elliptical; longer axis, 2·3″; shorter ditto, 2·0″; siphuncle, ·19″ wide, eccentric on the short axis; septa deep, not uniformly convex, but flattened convex at the top, with very steep sides. This fragment is the larger of two specimens (all obtained), which exhibit the peculiar flattened septum, from which the name is derived. Of the general form, nothing positive can be stated, though it is probable that the diminution in size at the larger end was very gradual, but somewhat more rapid at the smaller. The two specimens, though of very different diameter, exhibit the same general characters. The smaller, from a fracture, shows that the septa were ·16″ apart, the longer axis being 1″.

ORTHOCERAS *incertum*. Plate XXVIII., fig. 7.

Small specimen, tapering very gradually; section short ellipse; siphuncle not distinct in this specimen, but in larger fragments, small and central. Trace of iron pyrites over the surface of place of septum, which is moderately convex; a few obsolete annulations towards the end; much iron pyrites disseminated through the fragments, and the surface of one of them closely and transversely finely striated. There is nothing in these specimens to allow of accurate identification.

ORTHOCERAS *irregulare ?*—(Münster).

Count Münster (Beit., 1840, p. 100), observes—"More than twenty specimens, which I have obtained, exhibit on the shell of the same individual a very irregular striation, which sometimes is annular, sometimes undulating, sometimes obliquely curving, like a screw, sometimes faint, sometimes sharp." Some flattened fragments, though not so perfect as to be identified with certainty, may provisionally be referred to this species; the irregularity of the striation, however, consists of variations from fine and sharp to flat and wide striæ, or ridges, which occasionally appear to swell into an obscure annulation. Count Münster's localities—Elbersreuth and Prague.

Locality—Tyrone, *Desertcreat* schists. Sheet 37, Nos. 2 and 18.

DOUBTFUL ORTHOCERATITES.

ORTHOCERAS *triangulare*—(Portlock) Plate XXVIII. A, figs. 3 a, 3 b, 3 c. Var. of O. *anceps ?*—(Munster), Beit., 1840, Taf. IX., fig. 6.

Under the name Orthoceratites anceps, intimating a doubt as to its true origin, Count Münster describes a fossil from the Grauwacke of Gattendorf—"Two small imperfect specimens of this doubtful Orthoceratite do not admit of its accurate determination, although it seems, from its fine transverse striæ, to belong to the division with either transverse ribs or striæ; it is very conical, neat, depressed, with acute angles, one of which is provided with a small border; the shell appears to the eye smooth, but with a magnifier very fine faint transverse striæ are discernible. Neither siphuncle nor septa determined accurately, though the first appears to be marginal; length, eight lines; breadth, two lines;" a description which, taken from imperfect specimens, cannot be considered decisive as to the characters or nature of the fossil. Although, in some respects, it differs from those figured (Pl. XXVIII. A, fig. 3), the general resemblance is so great that it can scarcely be doubted that they belong to the same generic type, though it is highly probable they do not belong to the genus Orthoceras. When the external surface is seen, as in the upper and lower part of fig. 3 a, the sides are flat, and rise in the centre to a ridge which is rounded, and is marked by very fine faint transverse striæ. The general appearance is rather pyramidal than conical. On removing this external coat, which is thick, an internal nucleus is seen, which is quite pyramidal, the central edge, which is distinctly angular, corresponding to the rounded ridge of the external shell, and the sides having a margin, (as in Count Münster's figure), which appears to have been filled up by the external shell (see fig. 3 b). This inner surface is also finely and transversely striated. It is difficult to obtain a certain knowledge of the opposite side; but from the specimen figured (fig.3 c), it appears to have been nearly flat above, slightly ridged below, and marked by irregular longitudinal striæ or wrinkles. Other specimens also show this flat surface, but denuded of the external covering which this possessed: the section, therefore, may be reasonably assumed to have been triangular. In one specimen, the upper portion of the ridged side is bevelled off, and becomes quite flat at the top; but neither distinct septa nor any siphuncle have been discovered. Length of largest specimen, one inch and a half; breadth at top, three-eighths. The general appearance of these remarkable bodies is so unlike that of true Orthoceratites, and the angular nucleus exposed by the removal of the outer shell is so peculiar, that they can scarcely be referred to that family, but rather may be considered analogous to the internal bones of the Decapodous Cephalopodes; and it is, therefore, not improbable that this and Count Münster's species were representatives of that order of the Cephalopoda in these ancient rocks.

In Count Münster's Beiträge, 1840, several elongated Orthoceratites are described, which, although tolerably distinguishable under the circumstances in which they appear to have been observed by him, would not be so under less favorable circumstances. The upper, or unchambered portions, of Orthoceratites regularis (Beiträge, Taf. XVII., figs. 3, 4) and of O. speciosus (Taf. XVIII., figs. 1, 2, 3), would be perfectly undistinguishable, and the whole shells, if compressed, and the septa destroyed, would be equally so.

In O. regularis, the septa are very convex, and the distance between them considerable, being in the one figure ·44″, where the diameter is ·62″; in the other, exceeding at one point the diameter, and at another point being ·87″, whilst the diameter is 1·12″; differences sufficiently great to show the variableness of the character. In O. speciosus the septa are less convex, and the distance between them in one figure,·19,″ the diameter being ·62″; in the other a much larger individual, ·44″, the diameter being 1·75.″ Professor Phillips quotes O. regularis as a synonym of O. cylindraceum of Sowerby, and states the distance of the septa to vary from ·5 to ·75 of the diameter; in Sowerby's figures it is represented less than ·5, and in both the very convex form of the septa seems the only tangible character. Professor Phillips' fig. 213 c. (Palæozoic Fossils), is concentrically lineolated, and in the specimen which probably belongs to our O. tenui-cinctum no septa had been observed. In respect to external form, Orthoceratites speciosus is the most cylindrical of the two—Münster observing, "it increases so slowly in thickness that some specimens often appear cylindrical." In O. regularis, 9 inches of the upper portion are without chambers; in O. speciosus, 5 inches; in O. dimidiatus, nearly 6 inches; but in all three the chambered portion greatly exceeds in length the upper or unchambered portion.

ORTHOCERAS *regulare ?*—(Münster)—Plate XXVII., fig. 4.

The above remarks lead to the consideration of the smooth, flattened, and apparently unchambered bodies, one of which is here represented. They occur of various sizes, and diminish downwards so slowly that if the rate of decrease observed in the upper portion, not more than one-eighth of an inch in three inches, were to continue to the end, one of these comparatively thin bodies might extend to a length of three feet, like a walking cane. The extent to which these specimens have been chambered, it is impossible to determine, as no connected specimen has yet been found, and, from the nature of the material, probably never will; nor any trace of chambers observed in the specimens now under consideration. Fragments, however, occur, all being flattened, of various sizes, down to that in which chambers occur; and it is not therefore impossible that the chambered portion, Pl. XXVI., fig. 7, and Pl. XXVII., fig. 1, may be the termination of the simple unchambered portion. If such be the case, the great length of the unchambered, as compared to the chambered portion in these Orthoceratites, is extremely remarkable, and, taken in connection with the external shell or sheath, would constitute a new and very distinct type; it is, however, impossible to decide at present this doubtful question, and as chambers may have existed, though not now perceptible in crushed specimens, the species may be considered allied to the nearly cylindrical O. speciosus, and O. regularis. In most specimens the surface is quite smooth, but on one which in other respects is quite similar to the rest (Pl. XXVII., fig. 5), one part of the surface is smooth and another exhibits the remnant of a very thin shell, finely and transversely lineolated. The extent to which wear or accidental circumstances of any kind may have removed the striæ, must render it doubtful whether there is one or more species; there are traces of them on the large specimen, Pl. XXVII., fig. 4, as well as on fig. 5, but on others there are none. It has been already observed, that the great length of these remarkable bodies, combined with their very small comparative diameter, is in itself a peculiarity deserving attention. The smallness of their diameter lessens the difficulty of considering them internal, whilst their great length, and the thinness of their shell, increase its probability. Though some, however, may be thus readily admitted as internal shells, it by no means follows that all have been so; on the contrary, the family of Orthoceratites, even in this one respect, seems to include bodies belonging to very different types. For example, the fusiform Orthoceratites, for which the name "Gomphoceras" has been proposed in the Silurian Researches of Murchison, and since adopted by Münster, possess a tolerably thick shell, are comparatively short, and terminate in a chamber sufficiently large to have accommodated the animal; they, therefore, have probably been straight Nautili, though it would be unreasonable to consider the long slender bodies now under consideration as such. As a further ground of subdivision, Mr. Stokes has pointed out the remarkable variations in the form and relations of the siphuncle, and founded upon them several new genera, some of which he also considers to have been internal bodies, on the ground of their apparent length and the extreme thinness of their shell. In all these cases, however, the supposed outer shell has formed the lateral walls of the chambers, and no trace has been discovered of an appendage exterior to it, and consequently no approximation made to the structure of Belemnites, bodies now considered by naturalists the beaks of sepial bones. In the species to be here noticed there are certainly traces of some such appendage, and although its nature seems to have been different from that of Belemnites, it affords at least an analogical resemblance to them. The manner in which the chambered portion of the shell is invested at its sharp extremity by this appendage, is seen in Pl. XXVI., fig. 2; and the apparent continuation of the siphuncle as a tube through it in Pl. XXVII., fig. 1. In Pl. XXVI., fig. 1, it appears to extend up the shell for a considerable distance, and by the loose, irregular manner in which it has been crushed, would seem to have had very imperfect, if any, support by septa connecting it with the internal body. The exact nature of this appendage, it is difficult to determine, but being always crushed and cracked longitudinally down to the siphuncular tube, it has the appearance of two lobes, one on each side of it. In several of the Silurian species, now to be described, there are traces of this structure, and it is possible that it may have been more general; hence, there is a difficulty in making it the leading character of a distinct generic group; but at the same time it seems desirable to place so peculiar a structure in a prominent point of view by a distinctive name.

KOLEOCERAS, or sheathed Orthoceras.

The existence of this appendage below the terminating point of the chambers, and the siphuncular tube traversing it, may reasonably induce a belief, that the formation of regular chambers in the internal shell did not commence until the animal had passed the first stage of its existence. But how far the thin external shell or appendage extended upwards; whether it ultimately merged in the shell of the chambers, or was continued to the end as an envelope external to it; and again, whether one or both were internal to the animal, can only at present be conjectured. Mr. Stokes inclines to the original opinion of Mr. Miller, also adopted by Ferusac as the most probable one, that Orthoceratites were internal shells, an opinion founded on the extreme tenuity of their shell, and the great length to which it sometimes grows; conditions under which it would have been subject to numerous accidents, and exposed to the adhesion of foreign bodies (Corals, Balani, &c.,) by the increasing weight of which the supposed object of its mechanism would have been counteracted; the genus now under consideration consisted of such elongated bodies; but as many Orthoceratites are neither very long, nor covered by a shell of peculiar tenuity, nor remarkable for a terminal chamber, disproportionately small as compared to the closely chambered portion of the shell, it may be reasonably assumed that some of these shells were external, as in the Nautilus, and others internal, as in the Spirula, being formed on distinct types of organization. The determination of the species is attended with peculiar difficulty, almost all the specimens having been crushed, or more or less injured by pressure or in other ways. Considering Pl. XXVI., fig. 7, and Pl. XXVII., fig. 1, as immature forms, there is a considerable resemblance in general form to O. regularis of Münster and its allied species; the distance of the septa varying from only one-third to less than one-half of the diameter, and being, therefore, less than in the specimens of Professor Phillips. To the several species, therefore, I propose to give specific names, referring to their resemblance to those of Münster.

KOLEOCERAS *pseudo-regulare*.—Plate XXVI., fig. 2.

Internal chambered body, though slightly flattened, elongated, conical, its surface sometimes uneven, having been denuded of a very thin shelly covering, as may be seen from fragments remaining, more particularly at the aperture. The total length of the specimen is six inches, four of which are above the external appendage. The septa are somewhat oblique, and more than one-third of the diameter apart, in fig. 7, less than one-third; in Pl. XXVII., fig. 1, they are nearly direct, and are strongly concave. The apparent obliquity of the septa, and the oval form, (varying in different specimens), are probably accidental results of pressure. The appendage in Pl. XXVII., fig. 1, is seen for six inches in length, and may have been much longer; the impression of an annulated orthoceras at the top is apparently unconnected with it; it is remarkably crushed, and has the loose appearance of a sheath out of which some internal body had been removed; as before remarked, the external appendage is always cracked longitudinally down the centre, and below the point of the chambered shell, exposes, when removed, a fine siphuncular tube, the sac itself looking as if it were composed of two lobes, united at the siphuncle. The surface of the sac is marked by fine transverse lines.

When the external shell is tolerably preserved, the distinction between the internal chambered shell and the external appendage, is not seen, and the whole acquires a very elongated character.

KOLEOCERAS *pseudo-speciosum*, Plate XXVI., fig. 3.

Though this species is surrounded by a broken external sac or appendage, and therefore approximates to the preceding, it exhibits as well as can be judged from the flattened surface, about the same difference in respect to the distance of the septa, as O. speciosus (Münster) does in respect to O. regularis; it is also much more flattened than the preceding species, and this seems a general characteristic. It tapered very gradually, and the septa were less than ·25 of an inch apart. The total length of the specimen is seven inches, of which the upper two have no septa, and the lower two and a half are lost in the external sac. The breadth at top 1½ inch. The name is adopted to show the general resemblance to O. speciosus, though the evident existence of an external sac places it in this genus.

KOLEOCERAS *Ballii*—(Portlock)—Plate XXVIII. A, figs. 2 a, 2 b.

This remarkable fossil deviates so widely from the other species placed in this genus that it will probably hereafter become the type of a new genus, founded on the peculiarity of the internal shell, and on that account I do not construct the specific designation in reference to that peculiarity, but dedicate it to Robert Ball, Esq., Secretary to the Zoological Society of Dublin, a gentleman so well known for his attachment to, and knowledge of, natural history, and who has had the singular good fortune to add no less than four species of Cephalopoda to the Irish Fauna, two of which belong to the genus Rossia, before unknown to the British Seas.

Internal shell turbinated; five or six prominent or convex whorls, with a furrow or band along the centre; aperture rounded. This shell is surrounded by a loose sheath, which so conceals it, that the true nature of the fossil is at first quite obscured. On removing, however, a part of the sheath, the whorls of the shell appear as in fig. 2 b; and in some specimens a minute tubular prolongation from the apex of the shell to the end of the sheath is also seen. The nature of the sheath is apparently so completely the same as that of the sheath of the preceding species, even exhibiting the same tendency to crack in a longitudinal direction, that there can be little doubt of the identity of their origin. The shell was therefore internal, and the sheath a sac probably external to the animal.

GOMPHOCERAS.

In the Silurian Researches, page 621, the generic name "Gomphoceras" is proposed for those Orthoceræ which resemble in character Orthoceras pyriforme, an ovato-pyriform species in which the aperture is partly contracted partly expanded. The name is adopted by Count Münster, but so far as can be judged from his figures and descriptions, he depends more on the general spindle form of the shell, than on the form of the aperture. The position of the siphuncle varies and its form is not mentioned by Münster; by Murchison it is represented as beaded or swollen between the septa, and such is the case in a very distinct species which occurs in the mountain limestone, the name, therefore, may be applied to all those species which are more or less oval or pyriform, the final chamber narrowing towards the aperture.

GOMPHOCERAS *sub-pyriforme*—(Plate XXVIII. A, figs. 1 a, 1 b).
(Münster, cylindrical var. Beit., 1840. Taf. XX., fig. 8).

The only specimen sufficiently preserved, to be described, is so flattened that it must be mentally restored in order to compare it with Münster's figure. If it be presumed that the section was originally circular, or nearly so, the form becomes elongated, ovoid, the lower half divided by septa which are approximate, the distance between them being ·19″, the upper half occupied by a large terminal chamber narrowing at the aperture. The position of the siphuncle, &c., cannot be determined. Length of specimen 2·75″, and it may have extended further, as the bottom is not quite perfect.

GOMPHOCERAS *sub-fusiforme ?*—(Münster)—Plate XXIV., fig. 5.

This, like many of the fossils, has undergone compression; but as it would appear from its termination to be fusiform I am inclined to connect it with Count Münster's species, though the original form of the section cannot be determined.

Locality—Fermanagh, *Lisbellaw* schists.

PHRAGMOCERAS—(Broderip).

"Shell incurved and compressed, more or less conical; septa entire at their edges, crossed externally by the lines of growth; siphuncle near the inner margin; aperture contracted at the middle, its outer extremity produced into a sub-cylindrical beak. A genus distinguished from Orthoceras by being curved and having a nearly marginal siphuncle; also from all the species of that genus, except O. pyriforme, by the form of the aperture, which further distinguishes it from Cyrtoceras of Goldfuss, the aperture of which is round."

The peculiar form of the aperture here described cannot be verified by any of the Irish specimens, though there is an approach to it in Plate XXVIII. A, fig. 4 a; the more or less compressed character is general, and in all there is more or less of a lateral incurvation like that of the genus Hamites. Professor Phillips notices this peculiarity as affecting a division of the genus Cyrtoceras; but as the transverse section is by him stated to be elliptic, it is probable that the species so distinguished should be placed in the present genus.

Phragmoceras *inæquiseptum*—(Portlock)—Plate XXVIII. A, figs. 4 a, 4 b.

Slightly incurved; externally moderately convex, internally less so; the breadth is greater at the upper chambers, and it then narrows towards the aperture. Septa approximate, distance between them ·1″ towards the small end, and occasionally much less higher up, where there is considerable irregularity. No visible markings except what appear to have been the successive outlines of the aperture which is oblique to the septa, and on the convex side deeply and singly waved. The inner face is partly crushed, but naturally it was flattened, and the section an irregular ellipse.

Phragmoceras *arcuatum* ?—(Murchison)—Plate XXVIII. A, figs. 5 a, 5 b.

Slightly arched and incurved; section in the chambered portion more nearly circular than in most species, but more flattened on the unchambered part. The whole shell is gibbous and in this specimen has no markings.

Phragmoceras *compressum* ?—(Murchison)—Plate XXVIII. B, fig. 2.

Described in the "Silurian System as much curved, elongated, and compressed; marked with distant lines of growth; and is so much curved as to form nearly a circular hook. Longest diameter 3 inches, length of aperture 1¼ inch. Lower Ludlow rock near Aymestry."

Though our specimen is much larger and has a peculiarity of character in the great amount of its spiral twist, I am inclined to think it the same species as that figured Plate II., fig. 2, Sil. Sys., and drawn from a specimen which may have been part of a larger one. Compressed, very much curved, and contorted or twisted. Elongated; the portion drawn being 6″ in diameter and 3½″ in width of aperture, and it was only part of a larger. Surface marked by fine thread-like lines which are oblique to the probable direction of the septa. Septa not visible in the specimen which is much decomposed, soft, and ochreous. If it be correct, as here assumed, to consider Murchison's species and ours identical, it is probable that near the smaller end the shell became less twisted.

Locality—Tyrone, *Desertcreat.*

PHRAGMOCERAS *Brateri?*—(Münster)—Plate XXVIII. B, fig. 3.

"Described as slightly bent, ventricose, almost spindle-like, slowly decreasing towards the bent point; chambers narrow." (Beit., 1840. P. 105, Taf. I., fig. 10.) The section is elliptic in Count Münster's figure as in our specimen; but there is this difference in ours, namely, that it has the usual secondary bend or twist and, therefore, would not appear so straight as in his fig. a.

Locality—Tyrone, *Desertcreat;* that of Count Münster, Gattendorf, in the Clymenienkalk.

PHRAGMOCERAS ?—Plate XXVIII. B, figs. 4 a, 4 b.

This, though from the sharpness of its sides, evidently crushed, had probably an elliptic section. It was not so ventricose as the last, is very slightly bent and does not appear to have had the usual secondary twist; it, therefore, approximates either to Cyrtoceras or to Gomphoceras.

CYRTOCERAS ?—Plate XXVIII. B, fig. 6.

At the commencement of the bend the section appears to have been circular, but it is there flattened and suddenly attenuated. These appearances may be due, in part, to crushing.

It is to be regretted that several of the fossils last described cannot be determined in a satisfactory manner, in consequence of the nature of the matrix. They do not, like the fossils in limestone, admit of examination by sections; and appearing to have lost all traces of their internal structure, do not exhibit the septa or siphuncle. Even trusting, however, to their external appearance they differ generally from those of the Carboniferous epoch, though the genus Gomphoceras is still found in the mountain limestone, and the genus Cyrtoceras in the Devonian system, and probably in the Carboniferous.

LITUITES *cornu-arietis*—(Murchison)—Plate XXVIII. B, fig. 7, Var.

"Discoid; whorls about four; close, crossed by numerous, oblique, sharp, slightly raised costæ, mixed with lines of growth. Diameter nearly two inches."

There is a slight peculiarity in this variety of the species, by which it differs from those figured in the "Sil. Sys.:" the costæ and striæ are slightly bent forward at the back. In respect to the distance of the costæ, it is intermediate between the varieties α, β, of Murchison. The English locality is Llandeilo flags; and the variety β, is "from the black schistose beds of passage from the Silurian into the Cambrian rocks."

Locality—Tyrone, *Desertcreat.*

CARBONIFEROUS.

CYRTOCERAS *obliquatum ?*—(Phillips)—Pl. XXVIII. B, figs. 5 a, 5 b.

This fossil, found only in one locality, is too much injured to admit of correct identification; though it would appear to have been abundant in that particular place.

Some portions are nearly straight and then have much of the appearance of dorsal spines of fishes; but others are curved and twisted, as in fig. 5 a, and traces of septa can be discovered. The longitudinal crenulated ridges (fig. 5 c) resemble strongly those of Phillips' species which has a similar obliquity in the bent portion. It is, however, a doubtful fossil.

Locality—Tyrone, *Clogher*, in shale. I have placed this in immediate succession to the Silurian species for more direct comparison.

ORTHOCERATITES.—It is by no means easy to determine whether some of the elongated conical Orthoceræ, so common in the coarse schists of Desertcreat and Fermanagh, and which are there associated with fossils considered characteristic of the Silurian epoch, may not extend upwards into the Carboniferous strata, as very similar forms are there also common, more especially in the lower shales. The chambered portion, however, of the Orthoceratites, which have been described, appear, whenever it has been possible to trace them to their end, to terminate in an external sheath, whereas such termination has not at present been discovered in those of the Carboniferous epoch. The similarity of general form is rendered more striking by the crushed condition of the upper portion of the shell, which is common both in the shales of the Carboniferous system and in the schists (or hardened shales,) of the still older rocks; compare for example, Plate XXVI., fig. 7, and Plate XXVII., figs. 1 and 6, with the Carboniferous species, Pl. XXVII., fig. 8. The specific characters of many of the Carboniferous Orthoceratites, drawn up sometimes with reference and sometimes without reference to the external shell, seem to depend on very uncertain data; and when allowance is made for a reasonable variation from pressure or other circumstances, and for the different aspect exhibited by a fragment taken from near the point or near the base, to afford very feeble grounds of separation. This will be appreciated by comparing the several descriptions together.

Orthocera lævis (Fleming). "Conical, partitions waved: chambers large, two-tenths of an inch deep; syphon small and central, shell very thin; diameter increases two-tenths of an inch in one inch." Supposed by Fleming to be Ure's O. superficie lævi; but this must be considered doubtful, as the position of the siphuncle is not stated by Ure unless he is presumed to mean (the text being obscure) that the specimen with a beaded siphuncle belongs to that one of his two species; if so, the siphuncle is stated "to adhere to one side of the shell."

O. pyramidalis (Fl.) "Tapering, partitions slightly waved; chambers large, three-tenths of an inch near the base, and one-tenth near the point in depth; syphon small and central. Increase in diameter about 1·7″ in an inch, chambers near the point ·1″, near the base ·3″ deep."

O. cylindracea (Fl.) "Nearly cylindrical; partitions slightly waved; chambers numerous, scarcely one-tenth of an inch deep; siphuncle minute and central. Increase of diameter ·03″ in an inch."

O. circularis (Sowerby). "Smooth, gradually tapering, round; septa approximate, slightly concave, with even edges; siphuncle (pipe) half way between the edge and centre."

Orthoceras ovale (Phillips). Elongate; "section broad oval; septa without wave; siphuncle a little eccentric." It may be remarked that, in some Orthoceræ, the section is sometimes circular near the point, and oval nearer the base.

O. unguis (Ph.) "Suddenly arched towards the blunt end; section circular."

O. inæquiseptum. "Section round; septa very distant in the young shell."

Orthoceras conicum (Murchison). "Conical, smooth; septa near together; siphuncle central, cylindrical, large," whereas in Hisinger's O. conicus it is stated to be small; it differs also from O. conica of Min. Conch., now considered the alveolus of a Belemnite.

O. gregarium (Murchison). "Very gradually tapering, smooth; septa numerous, distant in the young shell, deep; siphon central, small; aperture round; length, four to six inches; diameter, about half an inch; resembling, but supposed to be distinct from, O. inæquiseptum of Professor Phillips." The figure represents the shell as marked by fine irregular lines.

Orthoceras cylindraceum (Sowerby). "Much elongated and smooth; septa rather distant." Mr. Sowerby remarks that the specimens are too imperfect to be positively identified; but he does not notice Fleming's species of the same name.

Orthoceras cylindraceum (Phillips). "Remarkably elongated; sometimes a little curved, smooth; section circular; septa very distant, from ·5 to ·75 of the diameter, deeply concave; siphuncle central, continuously cylindrical, and rather large." Taking these two descriptions together, and comparing them with that of Fleming's O. cylindracea, they do not all appear to refer to the same species; the septa in Fleming's are very close together, scarcely ·1″ apart; and in this more than two-tenths: the name, therefore, would more properly belong to the species of Fleming, as he first used it. Orthaceratites regularis, (Schlotheim and Münster,) has a strong resemblance, as suggested by Phillips, to his and Sowerby's O. cylindraceum; but it has yet to be determined whether this and other species have a continuous siphuncular tube, or one formed, as described by Münster, of short, detached, funnel-shaped tubes, which, extending only a short distance into the chambers, assimilate their structure to that of the Foraminifera.

Orthoceratites regularis (Hisinger). Is represented with a very small continuous siphuncle.

Orthoceratites conicus (Hisinger). "Elongate, conical, smooth; siphuncle thread-like and central;" evidently, both from the form and position of the siphuncle, not the O. conica of Sowerby (Min. Conchology).

Orthoceratites conoideus (Münster). O. gregarius, O. regularis, O. speciosus, O. acuarius, have all smooth shells, central siphuncles, and only differ from each other by a form approaching more or less to cylindrical, and by variations in the distance of the septa.

The simple consideration of these data is sufficient to show the probability that varieties of the same species have been described as different, and also that there has occasionally been a double use of the same name, by which very great confusion has been added to a family in itself sufficiently difficult of discrimination.

Of Orthoceratites, which, from their general form, as long, slightly tapering bodies, resemble the Silurian species, there are two, differing from each other in the distance of the septa. They have both circular sections, and small central siphuncles.

ORTHOCERAS *gregarium ?*—(Murchison)—Plate XXVII., fig. 8.
O. *gregarius*—(Münster). O. *inæquiseptum*—(Phillips). O. *cylindracea*—(Fleming).

The specimen here figured has been partly crushed: it is from the sharp end. Specimens from a higher part of the shell are identical with

Murchison's figure, and also with Fleming's (Ann. Phil., Vol. v. Plate XXXI., fig. 3), which appears to have been overlooked. The distance of the septa is about ·08″, and their form flat convex. Fleming's proportions of increase, as given in the description, are, however, those of a more cylindrical shell than his figure would intimate, namely, ·1″ in 3·75″, whereas in our specimens, as in his figure, the rate of increase is about ·1″ in one inch. With the figure of Count Münster our specimens appear identical; and it is worthy of remark that he represents the small chambers as continuing from the apex to the base, whereas Professor Phillips states that in his species the chambers are very unequal in the young shell. a statement repeated in the "Sil. Sys." The figures do not show the termination of the shell in either case, and there is some ambiguity in the term "young shell," by which Phillips appears to mean the shell newly formed, and not the shell of the young animal. The shell is moderately thick and smooth. Some minute specimens of the terminating end occur which have the appearance of a crow-quill, and are slightly bent. These resemble Fleming's O. attenuata, a species which also appears to have been overlooked. A Fermanagh specimen in dark limestone is 1·25″ in diameter, the distance of the septa being ·15″; it has a slightly oval flattening.

Locality—Tyrone, *Clogher*, in shales; Fermanagh, in light grey calcareous grit.

ORTHOCERAS *affine*—(Portlock)—Pl. XXVII., fig. 9. O. *conicus*—(Hisinger).

The proportions of this shell are the same as those of the last: its rate of increase being about ·1″ in an inch. It has a circular section near the apex, but it is usually flattened into an oval section towards the aperture. The distance of the septa is about ·16″. The septa are direct and more convex than in the last species. The siphuncle is central and small; shell smooth with irregular thread-like lines, as if a membrane had dried upon it. This closely resembles O. speciosus of Münster, but the form of that species is more cylindrical.

Localities—Tyrone, *Clogher*, in shale; Fermanagh, in light grey calcareous grit.

In the black limestone of Tyrone, *Carnteel*, Sheet 59, No. 11, there are many elongated nearly cylindrical Orthoceræ, generally slightly bent and flattened. The septa are not visible, and it is doubtful whether they belong to the preceding or to Sowerby's O. cylindraceum. They also have some resemblance to the small elongated specimens (Pal. Foss., Pl. XLI., figs. 205 c, 205 d), placed by Professor Phillips under O. laterale. It is indeed remarkable that both Mr. Sowerby and Professor Phillips record these uncertain forms, which may belong either to one or other of several species, amongst which is the next.

ORTHOCERAS *Breynii*—(Var. Sowerby).

It is very doubtful whether the species described by Sowerby is identical with that of Martin. In Martin's figure there is a distinct wave "in front, or in that part of the shell near which the siphuncle is situate." In Sowerby's the septa seem quite straight, or so nearly so, that the wave is "scarcely perceived." The shell is transversely oval, and the siphuncle eccentric towards the broad side. Septa approximate, in small specimens ·08″ distant.

Locality—Derry, *Desertmartin,* Sheet 40, No. 13, in blackish grey limestone with quartz pebbles.

ORTHOCERAS *circulare*—(Sowerby).

Described as round, gradually diminishing in size, with slightly concave septa. The distance between the septa is stated to be $\frac{3}{16}''$ and their margins even. The siphuncle is situated half way between the centre and the margin.

In the single specimen found, a fragment, there is a slight obliquity in the septa, but the distance between them is the same as above stated; the section is circular, and the siphuncle is about half way between the centre and circumference.

Locality—Tyrone, *Benburb.*

ORTHOCERAS *maximum*—(Münster.)

"The thick shell is smooth, the convex septa are approximate, the siphuncle unconnected, and proportionably wider than in other species; it is central." This approximates to O. Ludense (Murchison), but has a central siphuncle. The section of this Orthoceratite displays the curious structure shown in Count Münster's figure (Beit., 1840. Taf. XVII., fig. 2); but which is there confined to one chamber, as the siphuncular tube goes no further, having been probably obliterated from violence or disease. One-fourth of the diameter of the shell is taken up by what may be called the external siphuncle, which is formed of thick walls joining the septa, and, together with the sides of the shell, completely enclosing the space between. The thick septa which are thus connected with the walls of the siphuncle, do not pass across the centre of the shell, but are separated by a thinner septum which does, and at the centre is bent down into a very short open tube, which appears to be connected with and to support the internal membranaceous siphuncle. The internal siphuncle is irregular, being more or less swollen between the septa, but preserves a cylindrical form. This latter circumstance may, perhaps, be sufficient to separate the species from O. giganteum, should it also prove hereafter to have the structure which has been described, and this is probable, as a very slight deviation from the true line in cutting alters the appearance of the section by passing beyond the siphuncle, so that the latter may readily appear deficient. Count Münster supposes the internal siphuncular walls in his specimen to have been an anomalous production; but if so, it is remarkable that such a structure should exist in the six chambers of the specimen now under consideration. His specimens were large; in the unchambered portion five to six inches in diameter, and in the chambered three to four. The specimen now described is only ·75″ in diameter and 2″ long; but there is an unchambered portion, which either belongs to this species or to O. giganteum, 10 inches long and 4·5″ in diameter, the commencement of the siphuncle, which is eccentric, as in O. giganteum, being just visible. Count Münster suggests that this may be a variety only of O. regulare; but the septa appear too close together for that species; their distance in his specimen being ·56″, with a diameter of 2 inches; in ours ·25″, with a diameter of ·75″; and in intermediate specimens about the same proportion: so that there is a diminution in the distance of the septa according to their position, the chambers increasing with the growth of the shell; and it is even possible, therefore, that the shell described provisionally as O. affine may prove to be the apical termination of this shell, though on the whole it is rather less cylindrical.

Locality—Tyrone, the large specimen in black limestone; Kildare, in light grey limestone.

ORTHOCERAS *pyramidale*—(Fl.)
ORTHOCERAS *unguis ?*—(Phillips).

It is merely described by Phillips as "suddenly arched towards the blunt end; section circular;" and the specimen appears to have been very small and imperfect. The specimen I refer to Fleming's species is 11½ inches long, and is curved generally, though more so on approaching the apex; diameter at top, 2·6″; at the lower, ·6″, the point not having been preserved. Distance of septa at top, ·33″; near the bottom, ·25″; septa oblique; siphuncle rather large, or nearly equal to one-fourth the diameter; septa near the apex apparently circular, but near the aperture probably elliptic. The very sudden bend in Professor Phillips' specimen was probably accidental; whilst the tendency to bend, and the proportional distance of the septa, render it at least probable that it was the pointed end of an individual of this species, whilst the rate of increase and distance of the septa of our specimen agree with Fleming's data, though the siphuncle is a little larger.

Locality—Tyrone, in slightly calcareous grit. Specimen contributed by Captain Jones.

ORTHOCERAS *cylindraceum*—(Sowerby).

Section circular; siphuncle central, and about ·12″ wide, the diameter being ·8″; septa convex, and distant ·3″, the diameter being ·75″, or between one-third and one-half of the diameter. This differs from O. cylindracea of Fleming, by the perfectly direct septa, and their much greater distance. The chambers having been dislocated and slightly displaced after the matter of the surrounding matrix had filled them up, the specimen has a singular bent appearance. Professor Phillips also notices, and Sowerby describes, this species as occasionally bent. Sowerby cites O. regularis (Münster) as a probable synonym; but I think it a doubtful one.

Locality—Tyrone, *Clogher*, in calcareous earthy shale.

ORTHOCERAS *Gesneri ?*—(Martin). O. *canaliculatum*—(Murchison). Not O. *Gesneri*—(Phillips).

By Martin's figure it appears that the furrows are wide and shallow. In the specimen I refer to the species, they are almost obsolete, being just visible on the internal cast. The section is nearly circular, and the siphuncle central. The furrows are marked by longitudinal lines. Distance of septa, ·15″, the diameter being ·75″. The furrows appear rather more numerous than in O. canaliculatum, but there seems to be very little ground for separation. Phillips' species, in which the siphuncle is stated to be marginal, was most probably the O. angulatus of Wahlenberg.

Locality—In dark limestone.

ORTHOCERAS *reticulatum ?*—(Phillips).

Section circular, the shell rises at each septum into an annular ridge, and there appear to have been longitudinal lines. Septa convex, distant ·3″, the diameter being one inch; siphuncle eccentric, ·12″ in diameter; cylindric, but narrowed in at each septum, as if tied at intervals like a string of sausages.

ORTHOCERAS *latissimum*—(Portlock).

This is distinguished by its very rapid increase, the diameter being 2·75″, with a length of 3 inches. The septa are moderately convex, and distant ·22″. The siphuncle is lateral, at about one-third of the diameter from the margin, and in a section appears to have been compound, though not sufficiently preserved for identification. It probably belongs to Ormoceras, and though in some respects approximated to O. cordiformis (Sow.), is not narrowed at the aperture as in that species.

Locality—Kildare, in grey limestone; Tyrone, in red impure limestone; this specimen, however, is imperfect, and may be O. cordiformis.

ORTHOCERAS *sub-imbricatum*—(Portlock). O. *laterale*—Phillips.

Notwithstanding the attempt of Professor Phillips to remove the confusion with which the use of the same name for another species, by continental writers, had enveloped Sowerby's O. undulata, there is still some remaining obscurity in his specific names O. laterale and O. imbricatum, a consequence of the use of somewhat indefinite terms. The section is in each elliptic, and the proportion of the axes the same; septa oblique and waved in each; siphuncle in O. laterale eccentric on, or nearly on, the conjugate axis, in O. imbricatum, a little eccentrical on the conjugate axis. According, therefore, to Phillips, O. undulatum differs from O. imbricatum "by its less approximate septa;" a reference, however, to the description of Sowerby, as respects the one species, and those of Wahlenberg and Hisinger, as regards the other, will show that an equally essential distinction exists in the position of the siphuncle. In O. undulata (Sow.) the siphuncle is *near the upper edge*; in O. imbricatus (Wahl.) it is sub-central; if, therefore, the position of the siphuncle in O. laterale (Ph.) is sub-central, whilst its septa are distant, the species must be distinct from both O. undulata (Sow.) and O. imbricatus (Wahl.), which is by no means improbable, as the mere undulation of the septa is not in itself a sufficiently specific character; neither the description nor the figure decides this doubtful point, and I therefore use temporarily a new name.

Specimen a fragment; section oval; longer axis 1·62″, shorter 1·44″; septa strongly undulated, the distance between them ·25″ or about one-sixth of the mean diameter; undulating lines parallel to the septa; siphuncle small, slightly eccentric on the short axis.

Locality—Sligo, *Cloonoghill*, in dark limestone.

ACTINOCERAS *Simsii*—(Stokes).

The genus Actinoceras is distinguished by having a tube within the siphuncle, from which rays or radiating plates proceed, dividing the siphuncle into compartments by vertical partitions. The present species has, comparatively with its large size, shallow chambers, the distance between the septa being ·3″; they are not alone divided by the vertical partitions, but also by a horizontal division as shown in Mr. Stokes' figure, but not mentioned in his description; it appears to be generic, and therefore approximates the genus to Ormoceras.

Total length of one specimen, two feet; breadth at top, 5·75″; breadth at 2″ from the small end, 2·12″; length of unchambered portion, 1 foot 5 inches; thickness of septum, ·19″.

Locality—Down, *Castle Espy.*

There is a second species, in which the distance between the centres of two succeeding septa is ·9″; the distance in O. Simsii being only ·5″.

The distinction which Count Münster draws between the Orthoceratites of the transition and those of the mountain limestone deserves to be again specially noticed. The first, he says, all exhibit only narrow delicate siphuncles, which are generally situated in the centre of the septa, seldom between the centre and the margin, and are not composed of one continued tube, but of several very short, funnel-shaped tubes, which do not extend beyond the fourth, or at the utmost, the third part of the chamber. The Orthoceratites of the mountain limestone, and other strata, on the contrary, are distinguished by a thicker and continuous siphuncle, which is sometimes conical, and sometimes, in consequence of swellings between the septa, beaded or screw-formed; and in situation, sometimes marginal, sometimes between the centre and margin, and more seldom central. Similar differences between the form and position of the siphuncle, Count Münster states to characterize respectively the Clymenæ and Nautili of the older and younger formations. Enough, however, has been here stated to show that, though the narrow elongated Orthoceratites, which probably conform to the rule of Count Münster, are the more general species in the Tyrone Silurian strata, one species, at least occurs in them, though it is rare, having a large eccentric siphuncle, and in like manner that the small central siphuncle is not uncommon in the Orthoceræ of the Carboniferous epoch; taken as a whole, however, the Orthoceratites of the two formations are, in this district, strikingly distinct.

SILURIAN AND CARBONIFEROUS.

Conularia.—Though it has been proposed to remove these remarkable bodies from the Cephalopoda to the Rudistes, I still leave them in the former, as the authorities on the subject are, as yet, doubtful. In respect to the principal species, Conularia quadrisulcata (Sowerby), the specimens from the Silurian strata can, in some cases, be distinguished from those of the Carboniferous. In the Carboniferous specimens deep furrows at the angles bound the four lateral faces, but the faces are not themselves divided by longitudinal furrows (Pl. XXIX. a, figs. 4, 5). In some of the Silurian specimens (figs. 2, 3), the faces are subdivided by a well-marked mesial furrow, which, if constant, would have been a good specific character. At present I can only consider the distinction sufficiently striking to constitute a variety.

CONULARIA *quadrisulcata,* var. Silurian—Plate XXIX. A, fig. 3.

Sharply pyramidal; section probably quadrate, but there is no perfect specimen; lateral angles marked by strong longitudinal furrows; faces divided by a mesial furrow; transverse ridges formed of two separate halves, each of which is straight from the lateral edge to the central furrow, and the two inclined to each other at a very obtuse angle. They are crenulated on their edges by longitudinal furrows, which also pass over the transverse furrows.

Whether these bodies have actually been square pyramids, cannot, from the specimens, be affirmed; but it appears, from one specimen, that the sides could be separated and expanded like a fan, which seems a structure quite different from any of the Cephalopoda. That the central furrow is constant, appears doubtful.

CONULARIA *quadrisulcata,* var. Carboniferous.—Plate XXIX. A, figs. 4, 5.

In this species the ridges are generally more or less curved, sometimes forming one continuous bend over the face, but often separated in the centre, and then not always opposite, but alternating. As both forms are seen on the same specimen, the separation must be due to some peculiarity in the structure of the shell not yet fully understood. The ridges and intermediate furrows are crossed by longitudinal furrows, as in the preceding species.

Locality—Tyrone, *Benburb,* in shale; Armagh, in limestone.

CONULARIA *elongata*—(Portlock)—Plate XXIX. A, fig. 2.

Characterized by the very gradual decrease in its thickness; strong mesial furrow; transverse ribs on each side nearly in the same line, not forming an angle in the centre; furrows crossed by fine longitudinal striæ.

Locality—Tyrone, *Desertcreat,* in Silurian schists.

CRETACEOUS.

BELEMNITES.—Amongst the remarkable facts made known by a study of the ancient zoological conditions of the earth's surface, none perhaps are more curious than the simultaneous disappearance of two great families of organic creatures, the Trilobites from the Crustacea and the Orthoceratites from the Cephalopoda. Both were abundant in the Carboniferous period, both had ceased to exist in the Cretaceous; and had been replaced by other creatures of different forms, though of similar functions. Of these, the Belemnites are the most remarkable, and may be here considered with advantage, both because the alveolar portion of their shell has a considerable resemblance to and has been mistaken for Orthoceratites, and because in that section of the Cephalopoda which possessed thin narrow shells, probably two or three feet long, the Orthoceratite was an internal body and probably provided with an external coriaceous sac. The usual arguments for considering all Orthoceratites internal do not appear to me conclusive; as such creatures floating about in the deep sea, or moving rapidly through it, were in little danger of experiencing, on their exposed shells, such an accumulation of Balani, Serpulæ, &c., as should more than counterbalance the floating property of their internal chambers, and weigh down the animal; and in considering even this question, the Belemnites are of use, as they were furnished with a solid appendage to their internal bone. A peculiarly elongated character, combined with a small diameter, seems, however, to show that such Orthoceratites as possessed it were, from their form, as well fitted to act as strengthening supports to the animal, as, from their structure, to perform the office of floats; and hence, it is at least probable, as before suggested, that one section of Orthoceratites should be classed with the acetabuliferous order of Cephalopoda, and considered analogous to the Spirula, whilst another section should remain in the tentaculiferous order, and be considered analogous to the Nautilus. In the acetabuliferous section, therefore, of Orthoceratites, the chambered or alveolar portion has been principally developed: in the Belemnites a strong beak has been added to the alveolus on the one end and probably a horny bone at the other; in existing Acetabulifera the beak and alveolus have both become rudimentary, and ultimately in the Octopodes the horny bone has experienced a similar degradation. However interesting the history of Belemnites may be, I shall for the present confine myself to the more recent opinions on their true nature and object. Mr. Miller considered the spathose portion as originally formed solid, by the depositions of concentric conical layers, and the alveolar portion as entirely analogous to the chambers of the Nautilus: hence the one was a counterpoise to the other. Mr. Blainville, on the contrary, considered the spathose structure as the result of fossilification, and the whole body as analogous to the bone of the Sepia or Cuttle-fish; and further, he distinctly stated that it was symmetrical or divisible into two equal parts by a plane in the direction of its axis. M. Agassiz took a new ground, as he considered the Belemnite merely a part, or the beak, of the internal bone, and, therefore, not in itself a complete body; and acting upon this idea, M. Voltz pointed out its analogy to the bone of Omastrephes (D'Orbigny). Professor Phillips has in like manner investigated the relations of these singular bodies; and M. D'Orbigny in his two works, "Monographie des Céphalopodes acetabuliferes" and "Paléontologie Française," has given the latest published view of the subject. He considers the animal of the Belemnite analogous, not to the genus Sepia of the family Sepidæ, but to the genera Onychoteuthes, and Omastrephes of his family Teuthidæ. In this comparison the Belemnite itself becomes the rostral termination only of the internal bone, was not merely horny, but probably originally cretaceous, and was similar to the beak of the internal bone of some of the Sepiæ. The alveolus, with its chambers, was, though more highly developed, analogous to the small conical cavity ("godet") at the beak of Omastrephes; and they were both surmounted by and connected with a flattened and expanded horny bone, as in that genus. These analogies have been supported by the discovery of the impressions of the true horny bone, and may, therefore, be considered reasonable and well founded. The family of Belemnitidæ having been thus placed in immediate succession to the Teuthidæ, M. D'Orbigny divides it into two sub-genera, Belemnites and Belemnitella. In Belemnites "the cretaceous beak is elongated, conical or compressed, variable in form, posteriorly acuminated, anteriorly with an entire margin, contains in its interior a more or less numerous series of chambers pierced at their inferior edge by a continuous marginal siphuncle placed in a conical cavity; and as distinguishing the sub-genus from Belemnitella, it has no inferior slit at its anterior margin. It is also more variable in form, and in geological position as it descends from the Lower Chalk to the base of the Oolitic system, whilst Belemnitella is peculiar to the White or Upper Chalk. In Belemnitella, the cretaceous beak is distinguished by an inferior slit at the anterior edge, and by two *dorsal* lateral impressions which are not found in Belemnites. The sub-genus Belemnitella contains, according to D'Orbigny, only three species, the Belemnites Scaniæ (Blainville), B. quadratus (Blainville), and B. mucronatus (Schlotheim).

Belemnitella *mucronata*—(D'Orbigny). Belemnites *mucronatus*—(Schlotheim). B. *electrinus*—(Miller).

"Cretaceous beak, elongated, sometimes a little compressed, cylindrical on its anterior half, thence acuminated towards the very obtuse extremity, in the middle of which is a point often considerably prolonged; the two dorsal impressions are well marked, wide, and proceeding from it to the lower surface are small, ramified, and reticulated furrows. Ventral slit long, occupying half the cavity. Cavity round, very long, conical, occupying four-tenths of the length, furnished above with a longitudinal hollow furrow; alveolus with distinct septa, traces of which are also seen in the cavity. When young its form is more conical and slightly compressed."

This well known Belemnite is abundant in the Irish chalk. The cast of the cavity, B. electrinus (Miller), is common in the flints of Magilligan; the space occupied by the cretaceous beak around it being either left empty by the removal of its substance, or partly filled up by the little spheroids and spicula of Entobia. The species descends to the lower portion of the chalk, or to the conglomeritic bed of Tamlaght, where it is associated with Ananchytes ovatus, also supposed to be characteristic of the Upper Chalk, a curious coincidence which will be noticed hereafter, and the more remarkable as Belemnites minimus occurs in the glauconous chalk of the eastern edge of the basin at Larne, Glenarm, &c., marking it therefore as a distinct bed.

Locality—Derry, *Magilligan.*

PSEUDOBELUS—(Blainville).

This is a doubtful genus, proposed by Blainville and thus characterized:—"Body sub-cylindrical or conical, much elongated, with circular section, without cavity; fracture compact or sub-crystalline, with a sort of indistinct coating." The three species he named were all formed from fragments of from 1″ to 2″·5 long, and one of them, P. bipartitus, has been already shown by D'Orbigny to belong to the Belemnites. The principal peculiarity in the other two is, that the fracture exhibits an imperfectly crystalline and not a fibrous crystalline structure; as the want of a cavity is probably only apparent, the specimen not extending upwards sufficiently to arrive at the place of the cavity.

PSEUDOBELUS *striatus*—(Blainville).

The body I am disposed to refer to this supposed species, proves that it should either be removed out of the genus or the characters of the genus should be modified and enlarged, since, so far from not possessing a cavity, it possesses one of great length. A specimen 2″ long is at its smaller end ·3″ in diameter, and the section of the cavity is there ·12″, whilst ·8″ higher up the section is ·25″, the diameter being ·34″, and with the same proportional decrease towards the point, the cavity would cease to be visible when the diameter had become ·26″, and this is about the size of the specimen figured by Blainville. It is strongly striated or furrowed, in a longitudinal direction. Though those bodies have an external resemblance to some of the Dentalia figured by Goldfuss, the form of the cavity does not correspond to that genus.

They also resemble the elongated species of Münster's genus Petraia, which that author observes might be taken for Dentalia. There are probably two species, which will be hereafter illustrated by figures.

Locality—Derry, *Tamlaght.*

SILURIAN.

Bellerophon,—This genus was founded by Montfort, and described by him as being univalve, and chambered with entire septa pierced by a siphuncle. The Bellerophon vasulites, which was the typical species on which it rested, having been proved not to be chambered, the characters of the genus were subsequently amended and it was associated with the Monothalamons Cephalopoda of Lamarck. More recently it has been proposed to class it with the Heteropoda; and D'Orbigny has shown the analogy between one section of the genus and a recent species, Atlanta Keraudrenii. It is, however, not improbable that whilst some of the species belong to the Heteropoda, others were actually Monothalamous Cephalopoda, and I shall, therefore, describe them in connection with the Cephalopoda, and in this place, as they exhibit very distinct forms in the two great formations. The Nautiloid type of Polythalamons Cephalopoda has not occurred in the Irish Silurian strata.

The three species first to be described appear to form a natural group with Bellerophon bilobatus (Murchison); but from their crushed condition it is difficult to decide on the value of their specific differences.

Bellerophon *bilobatus*. Var. *compressus*—Plate XXIX., figs. 2 a, 2 b.

Is described by Murchison as "nearly globose, smooth; aperture two-lobed, 1·5″, width of aperture, 1·3″." All our specimens have evidently been crushed, and the globose character is therefore lost; but the bilobation of the aperture is very strongly marked. Specimens are frequently found in the condition of the right hand figure, the spire being exposed by the destruction of a portion of the shell. In fig. 2 b, the flattened character and the bilobation of the aperture are well shown.

Locality—Tyrone, *Desertcreat* schists.

Bellerophon *elongatus*—(Portlock)—Plate XXIX. B, figs. 4 a, 4 b.

Gibbous, elongated, ultimately expanding; aperture bi-lobed, though in old shells the bilobation is not so strongly marked as is usual in the group; length 1·5″, breadth 1·1″. In fig. 4 b, is shown the elongated character of the whorl.

Locality—Tyrone, *Desertcreat* schists.

BELLEROPHON *gibbus*—(Portlock)—Plate XXIX., fig. 5.

Very gibbous, as wide, or wider, than it is long; aperture bi-lobed, with a strong re-entering curve. It is smaller than the preceding. Length ·7″, breadth ·8″.

Locality—Tyrone, ***Desertcreat*** schists.

B. bilobatus of Murchison is in England a fossil of the Caradoc sandstone and Llandeilo flags; and this group is, therefore, one of great interest as highly characteristic of a lower portion of the formation.

BELLEROPHON *dilatatus*—(Murchison) Var.—Plate XXIX., fig. 1.

In the "Sil. Sys." B. dilatatus is described as "discoid, smooth; sides largely umbilicated; margin broad, slightly convex, with a central ridge; whorls few; aperture suddenly dilated to a much greater diameter than the spire, and inclosing it, orbicular.

This description exactly suits our specimens, excepting as regards the umbilicus, which is scarcely visible. The English is also somewhat larger than the Irish species, and in the latter the aperture shows no traces of furrows which were not, however, constant even in the English. It is highly probable that these highly expanded species will hereafter form a distinct group or sub-genus, and in that case our specimens will be separated and characterized by the nearly closed umbilicus.

Locality—Tyrone, ***Desertcreat*** schists.

CARBONIFEROUS.

BELLEROPHON *cornu-arietis*—(Sowerby).

The casts of this well-known shell are easily distinguished by the perfect separation of the whorls, and the rapid increase of their size.

Locality—Armagh, &c., but rare in comparison to the next species.

BELLEROPHON *apertus*—(Sowerby).

The smallest individual of this species is easily distinguishable from that of B. cornu-arietis, with which it has considerable analogy of general form, by this circumstance, that in B. cornu-arietis the inner volutions are quite apparent, and widely separated from the final volution—a consequence both of a very great thickness of the shell, and of an original separation of the whorls; whereas in this species they are only just apparent, the front of the inner whorls being even concealed by the outer whorl. The lateral depressions or shallow furrows, which render the "front rather prominent, so as to form a kind of depressed and dilated keel around the whorl," are nearly obsolete in these specimens, though a slight elevation of the front can be traced in some of the specimens. The form of the section, therefore, would be intermediate between that of B. cornu-arietis and B. apertus, as given by Sowerby.

Locality—Tyrone, Sheet 57, No. 2; in dark grey semi-crystalline limestone, numerous small crystals of calcareous spar and ochreous spots, the fossils having an ochreous coating.

BELLEROPHON *Larcomii*—(Portlock)—Plate XXIX., figs. 13 a, 13 b, 13 c (one-half N. M).

This species, known at present only by internal casts, is clearly distinguished from the preceding. The young shell is globose, being, if laid on its side, as high as it is wide, the consequence of the great width of the aperture; height to width of aperture as one to two and a half and one to three, increasing with the growth so as to swell out to a great width, being in the specimen figured seven inches, the length from back to front being about four. The inner margin of the whorl is deeply impressed with the front of the preceding whorl, producing a lunate form, as shown by the accidental section (fig. 13 c). This resembles the section given by Professor Phillips of B. cornu-arietis; but in that species, as before observed, there is a very wide space between the whorls: in this a very small one, indicating a comparatively thin shell. The front is much flattened, especially in old specimens, and in some there is even a trace of a depression; this and the low aperture produces, in young shells, a compressed form of volution, differing from that of B. apertus. From the rapid increase in breadth of this shell, viz., twice and a half in each whorl, the inner whorls are sunk deep below the plane of the outer. The shell is not preserved, and there are no markings on the cast. The great breadth of seven inches appears to have been attained in less than three volutions. I have dedicated this species to Captain Larcom, who, though not directly connected with this branch of the work, has conferred great benefit upon it by the perfection of the engraved maps, due, in great measure, to his superintendence of that department.

Locality—Fermanagh, Sheet 6, No. 29, in dark grey limestone, exactly like that of Tyrone, Sheet 57, No. 2, with crystals of calcareous spar and ochreous spots. Young in Tyrone, Sheet 57, No. 2.

BELLEROPHON *decussatus*—(Fleming)—Plate XXIX., figs. 6 a, 6 b.

"Shell somewhat longitudinally ovate, with numerous spiral ridges crossed by finer ones, giving the points of union a sub-tubercular aspect; mesial band rounded, longitudinally striated, decussated by the transverse fine ridges, which, in crossing, have a concave bend; slate clay of the coal formation, Linlithgowshire."

Locality—Tyrone, Sheet 68, No. 5; Sheet 65, No. 12; Sheet 64, No. 31, in shale.

BELLEROPHON *striatus*—(Fleming). BELLEROPHON *elegans*—(D'Orbigny). Not B. *striatus* of Ferussac, Bronn, or Murchison. Plate XXIX., figs. 7 a, 7 b.

" Longitudinally ovate, with numerous fine, slightly rough, spiral ridges; mesial band slightly flattened and longitudinally striated. This species differs from the last in the mesial band being more elevated, and in the nearly total absence of the transverse ridges. From same locality."

Locality—Tyrone, Sheet 68, No. 8.

Between the preceding two species, so admirably described by Fleming, no very decided line can be drawn, as gradually varying shades of difference may be traced from one to the other. In the one case the central band is very narrow, and the longitudinal striæ upon it fine, few, and decussated by the transverse striæ, which also, in crossing the spiral striæ, produce a distinctly granular surface. In the other the band is much wider, and its longitudinal striæ numerous, and not decussated; the transverse striæ so very slight as scarcely to decussate the spiral striæ. In addition to these extreme forms, which would constitute the two species, there are several other varieties. Sometimes, for example, several of the fine longitudinal striæ of the band occur close to it on the back, in addition to the several spiral striæ, and sometimes a portion of the spiral striæ are finer than the rest, as shown in the figure. In one specimen the raised longitudinal striæ on the band are strong, and in number three, thus corresponding exactly to D'Orbigny's Bellerophon clathratus (figs. 8 a, 8 b). In the same manner D'Orbigny's B. elegans evidently applies to B. striatus of Fleming, to whom, therefore, reference should have been made as the first discoverer and describer; whereas M. D'Orbigny's "localité" runs thus —" M. de Verneuil has discovered this pretty species in the Carboniferous limestone of Tournay (Belgium), and at Paffrath, in the Devonian system. It exists also in the vicinity of Glasgow."

Locality—Tyrone, in shale. Sheet 68, No. 5.

BELLEROPHON *Urii*—(Fleming)—Plate XXIX., fig. 9.

" Globular; sides of the aperture expanded; shell smooth, regularly sulcated spirally; the furrows shallow; the ridges rounded." This description is extended by D'Orbigny—" Shell thin, very globular, almost orbicular, although a little depressed, that is to say, a little wider than high, very regular, ornamented by thick short ribs, which follow the direction of the volutions of the spire. These ribs are nearer in the dorsal portion than on the sides; umbilicus marked by an impression so slight, that its existence can scarcely be indicated; mouth depressed, very narrow, transverse, and strongly arched, not enlarging laterally so as to form ears, as in many other globular species; carinal band slightly concave, separated, as it were, into two grooves by an elevated, sharp, longitudinal, and medial rib." From the terms of this description, as compared with that of Ure, it is probable that the species exhibits several varieties. Ure mentions no particular difference between the distance of the longitudinal ribs on the back and sides. In those, of which fig. 9 is one, there is no such difference; but one specimen exhibits an occasional interpolated rib, one being probably in the centre, and thus corresponding in some respects to D'Orbigny's description (see figs. 11 a, 11 b); it is, however, most probably a distinct species.

Locality—Derry, *Slieve Gallion*, in shales.

Another variety (fig. 10) has somewhat wider striæ, and in the carinal space there are two rather smaller ribs, placed between two larger, which are distant from each other about once and a half the space between the other ribs.

Locality—Tyrone, in shales.

BELLEROPHON *D'Orbignii*—(Portlock)—Pl. XXIX., figs. 12 a, 12 b.

This being determined from a single specimen, I feel some hesitation in separating it from the preceding: it is, however, a larger species, and the ribs are much stronger and wider apart. Globose, very slightly umbilicated; aperture wide, and comparatively very shallow, the proportion of the depth to that of the width not being more than one to six; longitudinal ribs comparatively few, strong, and slightly grooved. The cast in part denuded, is marked by raised lines corresponding to the ribs. The resemblance of this shell to D'Orbigny's recent species, Helicophlegma Kerandrenii, is so striking as to amount almost to identity. D'Orbigny had noticed this in respect to B. Urii; but it is even more striking in this species. It is, therefore, a strong reason, as urged by D'Orbigny, for considering this portion at least of the genus Bellerophon to belong to the order Heteropoda. According to his view, therefore, they are not Cephalopodous, but Heteropodous molluscs, belong to the family of Atlantides, and are nearly related to the genus Atlantis. Whether this view of the relations of the genus Bellerophon prove just or not, so near an approximation of a fossil of so remote an epoch to a recent species is, as a matter of fact, full of interest.

Locality—Tyrone, in shale. Sheet 64, No. 31.

A cast I have referred to this species exhibits the faint elevations corresponding to the ribs noticed in the description. It has obtained a larger size, being one inch from front to back, and is very globose. The aperture of the small species B. globatus of Murchison is much less closed than in this species; and it is even not impossible that B. globatus may be the cast of B. Urii, that species having been stated by De Verneuil, as quoted by D'Orbigny, to occur in the Silurian system.

Locality—Tyrone, *Derryloran.* Sheet 29, No. 1, in limestone.

BELLEROPHON *interlineatus*—(Portlock)—Pl. XXIX., figs. 11 a, 11 b.

Globose and expanded at the aperture; marked by fine spiral thread-like striæ, which are so arranged as to have one or more finer striæ between the stronger (fig. 11 b). Those near the centre are sometimes slightly raised, so as to form an obscure mesial band, which exhibits considerable variation; sometimes, for example, two fine striæ are interposed between a pair of stronger, and at others there are three strong striæ with finer between them, the central one forming a thread-like keel. This species is distinguished from others by the delicacy and number of the spiral striæ and the alternation of strong and fine striæ; in one specimen delicate curved transverse striæ are also visible which are arched over the band.

Localities—Tyrone, *Derryloran;* Fermanagh. Sheet 29, No. 1, reddish ochreous limestone; also in shale.

BELLEROPHON *Hiulcus*—(Sowerby). Var. minor.

" Globose, expanded, closely striated; central band flat, broad, defined; axis perforated. Close, sharp, elevated striæ that pass obliquely from the central flat band to the axis, distinguish this species, which is moreover wider than any other; the sinus in front is deep, and leaves arched striæ upon the band, as it is filled by the growth of the shell; the sides of the band are defined by sharp depressed lines; it is nearly the *eighth of an inch* wide." The small specimens that I consider a variety of B. Hiulcus are only ·3″ across the aperture; but the form of the band and striæ corresponds to that species; the band itself is not more than one-fifth of the width of that of B. Hiulcus, it is, however, depressed and not elevated as in B. tenuifascia. The influence of age on the breadth of the band is not sufficiently known at present to decide on the exact limits of species, in none of our specimens does it exceed ·06″.

Localities—Tyrone, *Derryloran; Cookstown,* in reddish limestone.

Bellerophon tenuifascia, and some other species also occur, for which see Addenda at the close of the list.

NAUTILUS.—Of fossils of the true Nautiloid type only one species occurs in the Silurian system of England, and not even one in that of Ireland. In the Devonian fossils of Professor Phillips they are recorded. In the lower shales of the Carboniferous strata of Ireland they begin to appear, and in some of the limestones are abundant.

NAUTILUS ? *perplanatus*—(Portlock)—Plate XXIX. A, fig. 11.
N. *complanatus?*—(Hisinger). Not N. *complanatus*—(Sow.)

Hisinger figures a Nautilus, about twice and a half the size of that here described, and yet agreeing so closely in characters and proportions, as to justify the belief that the Irish is only a minor variety of the Swedish. "Shell discoid, compressed; smooth, with nearly flat sides; front acute; aperture (?) lanceolate."—"Fragment from the transition limestone of Gothland at Hamra."

This shell is very much flattened; it is umbilicated, but the umbilicus is small and the volutions very nearly concealed. Dimensions of the specimen figured, two inches across and two and a half inches long. The front very nearly but not quite acute, and sloped or rounded off to the sides. The volution on one side of the umbilicus is three-quarters of an inch wide, on the other one inch and a quarter, so that in half a volution it has increased half-an-inch. Count Münster's Goniatites falcifer, Beit., 1840, Pl. XVI., fig. 7, approximates in external form to this species; but it is less flattened and exposes nearly one-third of the minor volutions, whereas in this the volutions are nearly all concealed. No marks of the septa visible on the specimens, although many (mostly broken) occur at this particular locality. As the name (*complanatus*) has been used by Sowerby for another species in which all the volutions are exposed, I propose the name *perplanatus*, as expressing the very great amount of flattening; though the genus may possibly be Goniatites.

It should be remarked that though Hisinger says expressly, "ambitu acuto," his figure agrees better with those of the Irish specimens which appear least acute; and it is very probable, therefore, that some portion of the acute appearance may be due to flattening from pressure or an imperfect clearing of the object.

Locality—Fermanagh, *Crevinish*, in brown shale. Sheet 28, No. 15.

NAUTILUS *planidorsatus*. Pl. XXXV., figs. 1 a, 1 b.
GONIATITES ? *planidorsatus*—(Münster). See also G. *truncatus*—(Ph.)

A larger and flatter shell than Professor Phillips', which is described as "very depressed, back (in adults) truncate; umbilicus open; fine transverse bent striæ." Professor Phillips' species was about half the size of this, and the back is represented as quite flat; in this it is slightly concave and narrower. The sides are much flattened; and the umbilicus represented by Phillips as open, but very small, is evidently in this also very small if not entirely closed. The surface is not sufficiently preserved to exhibit striæ; but the septa can be traced, and appear more suitable to the Nautiloid than Goniatitic type. Diameter of disc 3·5″, thickness at back ·3″; sides much flattened; outer edge shallow concave; septa very concave. This differs from Nautilus sulcatus, and some other species with flattened or concave backs, by the volutions being concealed. Count Münster's description, drawn up from very small specimens, is:—"Very flat, depressed, so that with a diameter of ·75″ the thickness is only two lines; discoid, quite involute, with a *large* umbilicus at the axis, the rim of which is in some specimens knotted. The back is quite flat as if planed; irregular lines of growth waved. It has only one recutering lateral lobe; the other lobes not perceptible on the specimens. The comparative size of the umbilicus may appear greater in small than in large specimens, and the back may also be then flat; I think, therefore, the identity of the species is at least very probable.

Locality—Tyrone, *Derryloran*, in light pinkish limestone; Sheet 29, No. 1.

NAUTILUS *quadratus ?*—(Fleming)—Plate XXIX. A, fig. 10.

"Discoid, whorls quadrangular, sides flat, smooth; outer edge flat, with numerous transverse concave striæ, and fine longitudinal ridges, four or five in number near the margin; chambers shallow, the syphon near the outer edge. In the cast the outer margin is flat in the middle, sloping off angularly to the edge; the sides with three longitudinal grooves." Carboniferous limestone, West Lothian.

The fossil, preserved in shale, which I here refer to this species, does not admit of a verification of the transverse striæ or fine longitudinal ridges. It is perfectly flat, with a flat back, the volutions fully exposed and gradually increasing, the disc being ·75″ in diameter with three whorls. The specimen figured is also very similar to Ellipsolites compressus (Sow.), but is much smaller and not elliptical.

Locality—Tyrone, *Clogher*, in shale.

NAUTILUS *sulcatus*—(Sowerby).

"Discoid, whorls exposed, ventricose near the inner margin; with two small spiral furrows, concave on the side; two keels toward the back which is concave; striæ fine, sigmoidal. Septa concave outwardly, siphuncle nearer the outer edge."

Our specimens are casts and do not show the striæ.

Locality—Cavan; Fermanagh.

NAUTILUS *sub-sulcatus*—(Phillips)—Var.

"Discoidal, smooth, with many sharp sigmoidal and some spiral striæ; whorls quadrangular, the back concave along the middle, bevelled to the side; the sides concave toward the outer edge, and convex toward the abrupt marginal slope, siphuncle near the outer edge, aperture oblong (analogous to N. sulcatus). Kildare; High Greenwood; Bolland; Coalbrookdale." Mr. Sowerby figures a Coalbrookdale variety in which the aperture is shorter. It agrees better with our species, which has also a slight groove close to and concentric with the umbilical margin, which may also be traced in Mr. Sowerby's figure. The sigmoidal striæ can only be discovered with a magnifier.

Locality—Tyrone, *Clogher*, in shale. Sheet 65, No. 11.

NAUTILUS *multicarinatus*—(Sowerby).

"Cylindrico-discoidal; back flattened, with many spiral ridges and furrows."

Locality—Tyrone, in limestone.

The four preceding species belong to the section Simplegas of De Blainville, in which the whorls are flattened and exposed like some Ammonites but the septa simple. The name was originally used by De Montfort for an Ammonite, as the septa were described by him as lobed and sinuous; "dentelées, lobées, persillées" in his typical species, Simplegades colubratus.

NAUTILUS *biangulatus*—(Sowerby).

"Discoid, sub-globose, with a large umbilicus, and a keel upon each side."

The angular sides here called a keel are sometimes very faintly marked. Professor Phillips observes, "a keel upon each side in *young* specimens." It is very probable that several species approximate to each other in this characteristic, as age alone does not appear to obliterate the keel; the casts are quite rounded.

Locality—Tyrone, *Carnteel.*

NAUTILUS *dorsalis*—(Phillips).

"Spire rapidly augmenting, so as to leave a large, very deep umbilicus; siphuncle *dorsal;* septa distinct."

It is very probable that some of the varieties mentioned by Phillips are really distinct species, the position of the siphuncle varying as well as the form of the umbilicus.

Locality—Kildare, in limestone.

NAUTILUS *goniolobus?*—(Phillips)—Plate XXIX. A, fig. 8.

The small fragment from the Clogher shales here represented, appears to belong to this species.

CRETACEOUS.

NAUTILUS *elegans*—(Sowerby).

"Gibbous, umbilicate, with numerous linear, reflexed, radiating sulci. About two-thirds as thick as wide; the septa are rather numerous, gently waved; the aperture is obtusely sagittate, with the posterior angles truncated; umbilicus small, perhaps closed." This is the most gibbous of a well formed group.

Locality—Derry, *Dungiven*, in white chalk; *Tamlaght*, in green ditto.

NAUTILUS *Mantellii*—(Sowerby, MSS.)

"Gibbous, sides slightly flattened towards the front; ornamented with numerous obtuse undulations which wave backwards as they pass over the rounded front. Aperture as long as it is wide, deeply sinuated by the preceding whorl. Umbilicus small, open. This differs from the N. elegans, in the greater distance of the undulations upon its surface, and in having an open umbilicus. The same species occurs in the lower greensand of Kent."

Locality—Derry, *Tamlaght*.

NAUTILUS *radiatus*—(D'Orbigny)—Sowerby ?

This is described by D'Orbigny as having a somewhat flattened, or compressed shell with rounded back, and ornamented with transverse regular arched costæ; sinuous over the back. Umbilicus fully open, showing the spires. Siphuncle small, placed at one-third of the diameter from the inner margin. Though the umbilicus is also open in Sowerby's species, it is less flattened and the costæ are wider apart than in our specimens.

Locality—Derry, *Tamlaght*. D'Orbigny's locality is "la craiè tufau de Rouen."

These three forms, though approximating to each other, can be made out with tolerable certainty; and N. Neocomiensis (D'Orbigny), seems to be a further deviation in the same direction from the type of N. elegans.

CARBONIFEROUS.

GONIATITES.—These fossils, which supply the place of the Ammonites in the Carboniferous strata, are highly characteristic of the formation, and more especially of the shales.

GONIATITES *granosus*—(Portlock)—Plate XXIX. A, fig. 9.

Orbicular; very slightly umbilicated, aperture very shallow, marked by fine raised spiral striæ which are beautifully granulated; a character which according to existing descriptions must separate it from any of the Carboniferous species. Septa not known.

Locality—Tyrone, Sheet 64, No. 52, in shale.

GONIATITES *striatus*—(Sowerby)—Var.

There appears to be considerable confusion in respect to this and the nearly allied species, G. sphericus; the difference of form being relied upon by Sowerby, the difference in the greater or less angularity of the septa by Phillips. Sowerby's figure does not show the extreme angularity of the first lateral lobe, which is considered characteristic by Phillips. In the present instance, the specimen referred to this species has an open and tolerably wide umbilicus, and the first lateral lobe is slightly rounded. Diameter 1·5″, thickness about ·75″.

Locality—Tyrone, *Clogher*; Sheet 65, No. 37, in shale.

GONIATITES *striolatus*—(Phillips).

The very small umbilicus, and the distinctly rounded lateral lobe, separate this species from the preceding, and its flattened form from G. sphericus. The distinction between it and G. obtusus, is not so palpable when the shell is deficient.

Locality—Cork, as well as in the Cavan district.

GONIATITES ————? ———

This is more depressed than the preceding. Umbilicus small; second lateral lobe more flatly curved and extends more to the front. Diameter 1·3″, thickness ·56″. The septa not being perfect, it cannot be fully determined. Resembles G. truncatus, but has not a truncated back.

Locality—Tyrone, *Clogher*, in shale.

At least one, and probably two other Goniatites occur in the Clogher shales; but the specimens are too much shattered to admit of satisfactory identification. The one is flattened with a broad rounded back, and is somewhat lengthened, and appears to have had sigmoid striæ: this may possibly be G. obtusus (Phillips). The other is a portion of a larger species probably 2·5″ in diameter, with faint sigmoid striæ and slight puckerings at the umbilicated margin.

Localities—Tyrone, *Clogher*, Sheet 65, No. 28.

AMMONITES.—Those of the Lias have been already noticed in Chapter IV.; they will not be here repeated, but will be inserted in the Synoptical Table.

CRETACEOUS.

AMMONITES *Lewesiensis*—(Sowerby).

"Discoid, obscurely radiated, radii large and obtuse; whorls depressed, inner ones half exposed; front narrow, rounded, plain; aperture sagittate."

Mr. Sowerby, after examining many specimens and noticing the gradations from one to the other, observes, "these specimens lead me to suspect the A. Lewesiensis is only a compressed variety of the A. peramplus." There appears also some difference between the figures of Sowerby and Mantell, in the proportional part of the whorl concealed. Our specimens more closely resemble Mantell's figure and have the back fully rounded. This Ammonite, so beautiful from the elegant sinuosities of its septa, is abundant in the lower or glauconus portion of the western chalk, and seems to mark the position of a distinct bed along its escarpment.

Locality—Derry, *Tamlaght*, &c., &c.

AMMONITES *alternatus*—(Woodward).

"Discoidal, thick, radiated; inner whorls one-third exposed; radii numerous, rounded, equally prominent, passing over the rounded front, alternately reaching nearly half across the whorl. Aperture elliptical, nearly half the diameter of the shell long."

Locality—Derry, *Dungiven*, *Tamlaght*.

AMMONITES *alternatus*—Var. (Sowerby, MSS.)

This differs from A. alternatus, only in having the sides of the whorls rather flattened towards the front, and the radii more numerous and less elevated.

Locality—Derry, *Tamlaght*.

AMMONITES *fissicostatus*—(D'Orbigny)—Var.

D'Orbigny cites as synonyms A. fissicostatus (Phillips), and A. venustus (Ph.), the latter being considered the young of the former. In Phillips' figures, however, the peculiarity of the species is not fully expressed. The shell is discoid, both thick and gibbous, with a broad, rounded back. The costæ close to the umbilicus, thicken into a tubercle and bifurcate; the two branches passing over the front with a slight bend forwards. Our specimen resembles D'Orbigny's fig. 2, Plate 76., more than his fig. 1; the latter being compressed. It differs from D'Orbigny's in some points: the tubercles are wider and flatter, and there is an occasional irregularity, a simple single costa occurring between two sets of paired costæ, or a single costa only proceeding from the tubercle. In some of these variations, it would more resemble Phillips' species.

Locality—Derry, *Tamlaght.* Foreign localities—Machéroménil, Novion (Ardennes), Varennes (Meuse) in the Gault, Wissant (Pas de Calais), &c.

In addition to the above Mr. Sowerby noticed, in a small parcel of fossils submitted to him for inspection, three other species which he considered new. They will be hereafter published with his drawings and descriptions. One of these, plain in " the cast, and marked with five or six furrows, produced by the edge of the aperture being thickened at as many successive periods," resembles A. cassida (Raspail), the costæ of which may have been connected with the aperture. It is considered by D'Orbigny a Neocomien fossil.

HAMITES.—There are two species considered by Mr. Sowerby new; one of these, he observes " approaches rather nearer to Turrilites in the form of its curve," and it very probably is a portion of one of the very large Turrilites recently published by Roemer.

SILURIAN.

GASTEROPODA.—Of this class representatives are found in every geological formation, and amongst them some of the most characteristic fossils.

EUOMPHALUS *sub-sulcatus*—(Hisinger)—Plate XXX., fig. 3.

" Shell conical with a wide umbilicus; volutions longitudinally sulcated or ribbed with minute transverse striæ, sometimes obsolete."

Gothland, in the more recent transition limestone.

Though the specimen here figured is imperfect there can be little doubt of its identity with Hisinger's. It is marked by longitudinal ribs set wider apart than in E. funatus, to which species, as remarked by Hisinger, it is closely allied. The transverse striæ are not perceptible in this specimen. Euomphalus funatus (Sowerby), is given by Murchison as a fossil of the Wenlock limestone. By Hisinger it is arranged with fossils of " the more recent calcareous strata of the transition formation;" but as the same section of his list contains also the Gryphæa arcuata, and Plagiostoma giganteum, it is evident that it cannot be taken as a strictly correct geological guide. See also Murchison's Turbo cirrhosus.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 6.

EUOMPHALUS *granulatus*—(Münster)—Plate XXX., fig. 5.

Beiträge. 1840, Plate 15, fig. 10 a.—Depressed: whorls few and very rapidly increasing. Breadth to height of whole shell about 1·12″ to ·25″; umbilicus and form of aperture cannot be determined from this specimen. Fine spiral crossed by equally fine curved transverse striæ. Taking only so much of this shell as would correspond in size to Murchison's E. tenui-striatus, the one might be considered only a more advanced stage of growth of the other; but the longitudinal or spiral striæ are not mentioned in that species, and as in this they are quite as distinct as the transverse it is better to consider it, at least provisionally, a different species. Count Münster describes his species thus: "Depressed, conical, four lines high and five broad below; the four volutions increase rapidly in breadth; the whole shell on the upper surface of the volutions as well as on the under surface of the base, is marked by narrow concentric striæ, which being intersected by longitudinal striæ produce a granular appearance; the opening nearly round." Allowing for some little compression, and for a further extension in growth of the last volution, this description suits extremely well the present specimen, given by Münster as rare in the "Clymenienkalk of Schübelhammer and Gattendorf."

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 6.

EUOMPHALUS *lineatus*—(Portlock)—Plate XXX., fig. 6.

Depressed, rapidly enlarging in three whorls to a diameter of 1·75″, marked by strong raised spiral lines and by very faint traces of transverse striæ. This appears to be the species represented by Count Münster, Beit., 1840, Taf. XV., fig. 10 b, as a cast of the preceding. It appears, however, to have strong claims to be considered specifically distinct. There is a fragment in which the spiral lines are undulated which will probably prove another species.

Locality—Tyrone, *Desertcreat.*

EUOMPHALUS *sculptus.*—Plate XXX., fig. 2.

Murchison, Silurian Researches, P. 12, fig. 17.—"Depressed, conical; surface ornamented with concentric furrows and elevated lines; whorls about three; aperture circular; umbilicus large. height eight lines; diameter nearly one inch and a quarter. The concentric lines and furrows, which are numerous but not deep, give an elegance to this fossil."

To this species I assign the fossil here figured, which is distinguished by its concentric furrows and elevated lines, although it appears rather more depressed in proportion than Mr. Murchison's. The umbilicus is deep; the volutions are nearly quite distinct from each other so that it approximates to the next genus; the form of the base is somewhat elliptical; aperture or section round. Murchison's locality is Wenlock limestone; Ledbury and Eastnor Park.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 50.

EUOMPHALUS *parvus.*—Plate XXXI., fig. 1.

Very depressed; rounded below with an obscure keel-like rise in the middle, and probably flattened above, having a sharp frontal edge; umbilicus very shallow; whorls exceeding three with a diameter of less than half-an-inch.

This shell has some resemblance to Planorbus Euomphalus (Sowerby), a shell of the under Oolite; the obscure keel which rises on the under side, the very shallow depression, and the less even plane of the upper surface, distinguish it.

Locality.—Tyrone, *Desertcreat.* Sheet, 37, No. 2 A.

ECCULIOMPHALUS—(Portlock).

In the Silurian Researches of Mr. Murchison a shell occurs, much resembling those to be here described, under the name of Cyrtoceras læve, and thus described:—"Elongated, pointed, curved into a semicircle, smooth, or only marked with lines of growth; generally compressed: we have not seen the septa." This last remark, "we have not seen the septa," leaves the fact of its being a cephalopodous shell uncertain. Goldfuss' characters of the genus Cyrtoceras, as given by Bronn, are, "Shell univalve, lengthened, and conical; smooth, striated, annulated, or knotted; chambered, curved at the point and then straight, so as not to form a continued disc round a middle point; septa convex with simple rims, pierced by a lateral siphuncle, which appears to me generally ventral but sometimes dorsal."

The typical species figured by Bronn is C. depressa, from which it is evident that this shell is a curved Orthoceras and, therefore, has symmetrical sides. Whether such is the case in Mr. Murchison's species cannot be decided from the figure; it certainly is not the case in the shell now to be described, which from that circumstance as well as from its great resemblance to an unrolled Euomphalus, is here formed into a new genus and classed with the Gasteropoda. Shell spiral, but with the whorls opened and unconnected; on the side corresponding to the upper surface of Euomphali, ridged or angular, on the lower rounded. As any combination of the Greek word κερας would suggest the idea of Orthoceras, &c., I have adopted a name suggesting rather the idea of an Euomphalus.

ECCULIOMPHALUS *Bucklandi*—Plate XXX., figs. 10 a, 10 b.

In less than three volutions this shell opens so much as to extend in the direction of its volution two inches and a half, whilst in the other it is only one inch and a half. It is marked on both sides with very fine thread-like striæ. I have dedicated this species to Dr. Buckland as one of the most eminent expounders of fossil zoology, and as the author of an able Paper on the Geology of Antrim and Derry.

ECCULIOMPHALUS *minor*—(Portlock)—Plate XXX., figs. 11, 12.

Though this may possibly be the young of the preceding, it is more probably a second species. The base (fig. 12,) is very delicately striated or threaded, and the upper or keeled side more strongly, though still finely, striated. It is less curved in at the spire than in the preceding. The figures are from different individuals.

Locality—Tyrone, *Desertcreat.*

SCHIZOSTOMA—(Bronn).

This new genus was instituted by Bronn, to receive those shells which, resembling the Euomphali in general form, have a slit in the outer lip of the aperture, similar to that of Pleurotoma and Pleurotomaria, a regular gradation of form is therefore established into the fusiform type by the several genera, Schizostoma, Pleurotomaria, Murchisonia (Phillips), and Pleurotoma; Scissurella being a branch in the direction of Turbo, and Pleurotomaria tending also by the loss of the band, &c., towards Trochus. Bronn says of these genera: "In the latter, Pleurotomaria, we have only those species with very narrow, or without umbilicus, as they also seem confined to the strata of the third period (Oolitic), whilst the Schizostoma extend from the first (Carboniferous), to the fourth (Chalk)?" On this principle most of the species here described would belong to the genus Schizostoma; our P. turrita being in all probability Schlotheim's Helicites delphinuloides, which is referred by Bronn to Schizostoma. This arrangement would bring together widely different forms, and be in opposition to the principle of Professor Phillips' genus Murchisonia, founded merely on a more elongated form of the shell. Bronn places Euomphalus catillus (Sowerby), in the genus Schizostoma, and correctly quotes as a synonym Schlotheim's Helicites delphinularis, but cites by mistake the wrong figure, Tab. XI., fig. 4, instead of Tab. XI., fig. 5.

SCHIZOSTOMA *latifasciatus*—(Portlock)—Plate XXX., figs. 4 a, 4 b.

This species forms a connecting link between the Euomphali and Pleurotomariæ here figured. It differs from P. sub-rotundata by a less rounded final volution and a less elevated spire. The under surface resembles much that of Euomphalus discors (Sowerby); but the upper wants the strong spiral ridges and transverse plaits of that species and

E. rugosus (Sowerby); conical, few volutions, having one wide and rounded band. Transverse striæ, which at and over the band are bent backwards into a strong well marked curve, more distinct even in the cast than in the external surface. The striæ on the shell both above and below are sufficiently strong to be called fine plaits; on the cast they are finer, and especially on the under surface of the base. The aperture in this, as in most of these species, is lengthened downwards, in consequence of the rapid increase of the volutions. The band in this species is near the upper edge of the volution, a further difference between it and P. sub-rotundata.

PLEUROTOMARIA.

The slit in the outer lip of the aperture on which the name has been founded, is seldom visible, as specimens are rarely found perfect; but the peculiar bending transverse striæ, curved backwards to and marking the line of the slit are always a prominent character.

PLEUROTOMARIA *turrita*—(Portlock)—Plate XXX., figs. 7 a, 7 b.

Conical, breadth about equal to the height; band narrow, marked by distinct boundary lines, or thread-like keels, with a supplementary one in some specimens above the upper; volutions rather depressed above the band and nearly vertical below it, but in this respect subject to some variation; a considerable portion of the volution below the band left uncovered by the succeeding one, producing a turreted or pagoda-like appearance. The transverse striæ are bounded above by a raised line or rim and curve backwards to the band; where the under surface of the last volution can be discovered there appear spiral lines more or less distinct. The mouth is nearly round and slightly twisted at the columella, but without any canal. It is probable that both this and the succeeding species would be classed by Professor Phillips in his new genus Murchisonia, "a sort of elongated Pleurotomariæ or Schizostomæ." The present one has also considerable resemblance to Pleurotomaria conica (Geol. Yorkshire, Plate 15, fig. 22), which Professor Phillips thus describes: "Conical, acute, umbilicate; band bicarinate, striæ acutely elevated and oblique above. Some varieties have three keels, a sulcus separating the two upper ones. On some specimens are spiral striæ." The specimen here figured is imperfect at the aperture; but the only perceptible variation from Professor Phillips' description is that the striæ above have a slight bend and do not come down in a simple curve (nearly straight) to the keels, and that more of the volutions are exposed below the bands. In some specimens the band is less distinct. Schlotheim's Helicites delphinuloides differs from this only in a wider band.

Locality—Tyrone, *Desertcreat*. Sheet 37, Nos. 50, 2 A, 2.

PLEUROTOMARIA *sub-rotundata*—(Portlock)—Plate XXX., fig. 8.

This differs from any of the Carboniferous Pleurotomaria figured by Phillips, by the large proportion of the upper volutions below the band left uncovered by the succeeding whorls, which gives the fossil an elevated appearance in its upper portion. Last whorl large and rounded, having the form of P. undata (Silurian Researches), but no strong transverse waves; and it is further distinguished from that species by the peculiar character already noted. Turreted; a considerable space below the band being uncovered by the succeeding volution. Band strongly marked in the upper volutions where, when decorticated, it appears bi-carinated, less so in the final whorl. Transverse waved striæ strongly marked over the band; aperture lengthened downwards. When decorticated the whorls appear quite round; the internal cast, therefore, might readily be confounded with other genera. It is not unlike Helix cirriformis (Sow.)

Locality—Tyrone, *Desertcreat*. Sheet 37, No. 6.

PLEUROTOMARIA *trochiformis*—(Portlock)—Plate XXX., fig. 9.

Conical; band slightly elevated with sharp edges, and being close to the base of the volution the whole shell acquires an even regularly sloped appearance; base nearly flat; height and breadth nearly equal, exceeding one inch. This species is even more nearly allied to Phillips' P. conica than the preceding; but it is less elevated and less turreted, and not showing any of the volution below the band, merges into the form of the genus Trochus. The gritty variety of the rock in which these specimens occur has only imperfectly received the markings of the surface; the curved transverse striæ can, however, be sufficiently traced to verify the genus.

Locality—Tyrone, *Desertcreat*. Sheet 37, Nos. 5, 6.

TROCHUS *ellipticus*—(Hisinger)—Plate XXXI., fig. 1.

Leth. Suec., Plate 11, fig. 1.—This remarkable shell closes the series of forms graduating from the true Euomphali to the Trochi, as it has lost all trace of a spiral band or transverse curved striæ. It is thus described by Hisinger: "Shell conical with an oblong or elliptic base; volutions nearly smooth and having a margin or rim." Hisinger's figures are an upright view of the narrow end, and a horizontal view of the base. In this specimen the longer axis is one inch and the shorter three-quarters, and the view faces the longer axis. The apex is injured, but there appear to be four distinct volutions; a small furrow marks the separation of the volutions which are margined above and below by a thread-like rim; surface quite smooth. The Swedish locality is in the transition limestone of Dalecarlia at Furndal.

Locality—Tyrone, *Desertcreat*. Sheet 37, No. 2 A.

LOXONEMA—(Phillips).

Spiral, turriculated; whorls convex, their upper edges adpressed against the next above; without spiral band; mouth oblong, attenuated above, effused below, with a sigmoidal edge to the right lip; no umbilicus (?), surface covered by longitudinal threads or ridges generally arched."

LOXONEMA *obscura*—(Portlock)—Plate XXXI., fig. 3.

From the state of preservation of the specimens of this shell, it is difficult to decide upon its true character; though as a common shell in the Silurian schists it could not be omitted. In 1·25 of an inch there are about six volutions, the breadth of the last whorl being ·4″. The whorls are convex with a slight appearance of an angle, so slight as to be overlooked in most of the specimens. Under the magnifier very fine bent striæ may occasionally be perceived, but they are usually quite obliterated.

Locality—Tyrone, *Desertcreat,* in coarse schist; though non-calcareous the fossil is filled with carbonate of lime. Sheet 37, No. 2 A.

POLYPHEMUS ?—(Montfort).

"Sowerby (Trans. Geol. Soc., Vol. v.) has revived for a fossil of Coalbrookdale, this generic name, established by Montfort for a section of the genus Bulimus. That a land shell should be found in a coal-field, would not, perhaps, be very surprising; but it would be curious to observe the same form in strata of a more decided character. Montfort's characters are, "Shell free, univalve, elongated; with a regular mammillated spire; mouth narrow, columella smooth and truncated; base notched; the last whorl greater than all the others taken together." He remarks also that, "the genus is remarkable for the curvature of the base of the columella, and for the outer lip which is not marginated, and does not form on the whorls any suture or varices which might indicate the position of former apertures." The Polyphemus glans, he adds, lives in the interior of Louisiana, in the midst of the immense marshes formed by the overflowing of the great rivers which water that vast country. Notwithstanding, however, the great similarity of form there is a difference in at least one point; the spire of Polyphemus is mammillated as in Bulimus, whilst it appears to have been sharp in the species now proposed to be referred to it. It would, therefore, be advisable to adopt the same principle which has been applied to Melania, and call the genus Polyphemopsis, which would, therefore, be distinguished from Polyphemus by a sharp spire, and probably also by the want of a wave in the outer lip of the aperture. The aperture is different from that of Macrocheilus (Phillips); and it does not, therefore, appear correct to refer P. fusiformis (Sowerby) to that genus.

POLYPHEMOPSIS *elongatus*—(Portlock).

Elongated, fusiform, and smooth; the lines of the whorls being traced with difficulty. In a length of 3·1″, there were probably six whorls. Whole shell narrow, the breadth as compared to the length 1 to 3, and probably still less if the shell had not been partly crushed. Aperture long and narrow, nearly equal to half of the length of the shell. Columella smooth and evidently bent, though not so much as in the Carboniferous species; in some specimens it has evidently been truncated. This curious fossil when seen on the back, as in the left hand figure, is very unintelligible, but the aperture is readily discovered. It is possible that Murchison's Buccinum fusiforme may belong to this genus.

Locality—Tyrone; *Desertcreat.* Abundant in one bed and at one spot.

PATELLA *Saturni*—(Goldfuss)—Var.

"Shield-like, convex, smooth, with only a few concentric rugæ; outline of base oval. The vertex sharp, upright, and anterior to the centre. Rare in the Eifel and at Paffrath." The specimens referred to this species are more elevated than in Goldfuss' figure, and the vertex is sometimes more and sometimes less in advance of the centre; these, however, are unimportant variations. The outline is oval; in one specimen the axes are as ·5″ to ·37″, and the height ·32″; in another, more compressed, the axes are as ·41″ to ·28″, and height about ·25″. Surface smooth with faint concentric rugæ and traces of concentric striæ. If this is to be separated from the species of Goldfuss, the greater elevation, together with a slight flattening behind the vertex and a little more fullness in front of it, would constitute its peculiarities. Traces of concentric striæ are also perceptible in the casts, which are not mentioned in Goldfuss' description; but as they are only seen in these specimens with difficulty they may have been entirely obliterated in Goldfuss'. The upright and elevated vertex, which is the leading characteristic, is present in all.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 2 A.

METOPTOMA ?—There is one species apparently of this genus, but it cannot be described from the specimens. The vertex is low in proportion to the extent of the base, or about one-third of the longer axis. The shell is irregular and quadrate in its outline.

CARBONIFEROUS.

EUOMPHALUS *pentangulatus*—(Sowerby).

"A prominent central ridge or rising angle on the upper side, the other side obtusely angulated. Striæ of growth hair-like. Volutions almost wholly exposed. Aperture obscurely pentangular, rounded on the outer side. The under and umbilicated side much deeper than the upper, which approaches to flat. There are about six whorls. Greatest diameter from ·5″ to 2″." Such is the normal form of this characteristic shell; but there are several curious varieties. One of an elliptic or elongated form, appears as if squeezed together in a lateral direction; but in it, as in the normal one, the spire is so much depressed as to be level with the general plane of the upper surface. In another it rises above the plane as in the figure given by Bronn. In the one case a horizontal section cuts through all the whorls, in the other it would not; and these varieties appear to have a local constancy. I am inclined indeed to consider the latter a distinct species and to name it E. Bronnii.

Localities—Normal form and elliptic form, Kildare and Dublin, but in different quarries; elevated form, Tyrone, Armagh.

EUOMPHALUS *Dionysii*—(Goldf.) HELICITES *Dionysii*—(Schloth.) CIRRUS *rotundatus*—(Sowerby).

"Conical, nearly smooth; whorls convex; umbilicus large; aperture round."

In this species the spire is elevated, and the whole character of the shell, which belongs to the Cirrus type, very different from that of the preceding one.

It is a characteristic shell, in a peculiar band or bed of limestone in the Counties of Tyrone and Fermanagh. Klöden remarks, "it occurs with *Calamopora* (*Favosites*) *fibrosa*, in a grey, mottled with yellow and green, mountain limestone, at Wrietzen, Berlin, and Potsdam," of which our grey limestone with its ochreous spots may be considered a fair representative.

Locality—Tyrone, *Carnteel*. Sheet 57, Nos. 2, 4, large variety corresponding to the true E. Dionysii; Sheet 64, No. 5, small variety corresponding to Sowerby's figure of Cirrus rotundatus. They all occur as casts.

EUOMPHALUS *tuberculatus?* DELPHINULA *tuberculata*—(Fleming).

"Discoid, whorls striated spirally and transversely, with a row of transverse tubercles on each side. In Carboniferous limestone, West Lothian." Instead of nodular projections as in E. nodosus, E. bifrons, E. pugilis? there are strong transverse tubercles. The specimen is a fragment only, and being a cast, does not show the transverse or spiral striæ.

Locality—Tyrone. Sheet 59, No. 11; black limestone.

EUOMPHALUS *catillus,* (Sow.) young. SCHIZOSTOMA *catillus*—(Bronn).

Locality—Armagh, in limestone.

PLEUROTOMARIA *cancellata ?*—(Phillips).

"Volutions very few, tumid; surface minutely and regularly reticulated, the crossings of the lines set with prominent puncta." The shell I here refer to this species has only a small portion of the shell preserved, which has been thick; but even on the cast the knotted intersections of the striæ can be traced in several places. There are four volutions in our specimen.

Locality—Boundary of Tyrone and Monaghan. Sheet 59, No. 81, in dark limestone.

A form occurs in the shales of Ballynascreen closely allied to P. atomaria; the base convex, the spire tabulated, that is, the whorls flat above, two spiral sharp carinæ, but the surface does not appear to be reticulato-striated; strong spiral lines (probably two) can be traced below the carinæ, and they become on the final whorl distinct threads.

LOXONEMA *tenui-striata*—(Portlock)—Plate XXXI., fig. 4.

Spire elevated and attenuated; whorls about eight, with a gentle swell near the base, and a slight contraction at the top, where the striæ are more strongly marked, though not so much so as to amount to crenulation. This has a considerable resemblance to Martin's figure of L. constricta, but his description expressly mentions the "crenated narrow belt along the upper margin." The striæ are very fine, and sigmoidal. The aperture is imperfect, but it appears to have approached more to the form of that of Buccinum than in Phillips' conjectural form.

Locality—Tyrone, *Aghalurcher.*

MURCHISONIA—(Phillips).

"Proposed (in MS.) by De Verneuil and D'Archiac, to include Buccinum spinosum and B. abbreviatum of Sowerby, Turritella bilineata of Goldfuss, &c.; this generic group will also include a variety of the Turritella of my work on mountain limestone fossils, which are there marked by the spiral band, bent striæ, and elongate figure. They are a sort of elongate Pleurotomariæ or Schizostomæ, and, like them, were notched on the middle of the right lip."—(Phillips' Pal. Fossils, page 101.)

MURCHISONIA *angulata*—(Phillips)—Plate XXXI., fig. 5.

General figure fusiform; whorls rapidly diminishing in size at the base (less so at the vertex), angular, the upper ones triconnate. The upper keel runs along the angle; the second is immediately below; the lower, or third, is sutural. The two upper keels constitute together the characteristic mesial band of the genus." Phillips' specimen was very small, and that figured in Geol., Yorkshire, as Rostellana angulata, was also from a higher part of the spire, and more contracted at the base of the whorls than in our specimen. The keels are crenulated by the striæ. When the shell is perfect, the lower keel is concealed by the following wherl. The lower half of the whorl is nearly vertical, and the striæ are retroflexed to the keels, or angle of the whorl. The aperture was angular, and the genus must be considered doubtful.

Locality—Tyrone, *Aghalurcher.*

MACROCHEILUS—(Phillips).

Professor Phillips has proposed this name (Pal. Foss., page 103,) provisionally for shells hitherto classed under the genus Buccinum, from which they essentially differ by the form of their aperture, which does not terminate in the characteristic notch of that genus. The Professor has not characterized the genus, and it is evident from his figures and descriptions that the specimens referred to it have rather a wide range of character, and should most probably be formed into several genera, one of which would embrace those possessing the narrow, elongated upwards, acute-angled aperture, and curved columella; and another those with a more expanded aperture but without the notch of Buccinum.

MACROCHEILUS *imbricatus*—(Sow.) VAR. *rectilineus*—Plate XXXI., fig. 9. BUCCINUM *rectilineum*—(Phillips).

Five distinct whorls; whorls rounded and swollen, with a slight flattening above; apex very acute; aperture slightly expanded above, but generally narrow; columella smooth and suddenly bent, with a slight but uncertain appearance of truncation; striæ very fine and nearly direct. More swollen than B. imbricatum and flattened at the summit of the volutions.

Locality—Tyrone, *Aghalurcher.*

MACROCHEILUS *percinctus*—(Portlock)—Plate XXXI., fig. 10.

This fine shell has only occurred in an imperfect state, the best specimen being that drawn. It exhibits much of the aspect of a Buccinum, but the aperture cannot be discovered. The whorls were large, moderately swollen, and marked by strong spiral elevated striæ, or sulci, according as the raised or depressed markings are taken into account. The shell is 3·8″ long, and the diameter of the whorl is 1·8″. It resembles in its striation and size some of the large Melaniæ figured by Roemer in his fossils of the Oolites, and has also a resemblance to the recent Buccinum striatum. In Buccinum parallele (Phillips), the upper part of the whorl was plane and finely striated, and the lower part furrowed; in this species the whorl is uniformly furrowed.

Locality—Tyrone, *Derryloran.*

NATICA *plicistria* Var. *a.*—(Phillips)—Plate XXXI., fig. 6.

"Oval, depressed, columella not callous; spire of three volutions, plicistriate above. *a.* Volutions flattened above, with age concave. *β.* Volutions not flattened above." Our finest specimens belong to the first, or variety *a*, as the volutions are flattened above; the spire is rather more depressed than in Phillips' figure, but that is the result of a different period of growth.

Localities—Armagh, Tyrone, in reddish limestone.

NATICA *plicistria* Var. *β.*—(Phillips)—Plate XXXI., fig. 7.

In this variety, the volutions are not flattened above and the shell is proportionably smaller, but in other respects there is no material difference. As a constant difference, however, in various localities, it should probably be made the foundation of specific distinction.

Locality—Tyrone, in limestone.

NERITA *spirata*—(Sow.)—Plate XXXI., fig. 8.

Little more than two whorls visible in the few specimens possessing the characters of this species. The last whorl wide and much flattened at top, the spire being so little raised as to be nearly on the plane of the flattened whorl. The striæ, as in Sowerby's description, are slightly plicated on the upper surface of the whorls.

Locality—Tyrone, *Derryloran,* in reddish limestone.

TURRITELLA? *sulcifera*—(Portlock)—Plate XXXI., fig. 11.

This minute shell, having ten whorls in less than one-third of an inch, is narrow and elongated, and has its whorls marked by spiral sulci, bounded by strong spiral ridges, of which there are four on each whorl. The form of aperture not known, as this was the only specimen possessing the characters.

Locality—Derry, *Desertmartin,* in shale.

CRETACEOUS.

A few only of the fossils of this class will be at present enumerated.

CIRRUS *depressus*—(Sowerby).

Locality—Derry, *Tamlaght.*

TURBO ? *bicarinatus*—(Sowerby, MS.)

" Conical, elongated; whorls four or five, very distinct and convex, with two slight, parallel, rather distant ridges winding up below their middle. Aperture nearly round." The name, however, is pre-occupied.

Locality—Derry, *Tamlaght*.

TURRITELLA *unicarinata*—(Sowerby). CERITHIUM *unicarinatum*—(Woodward).

" Turreted, elongated; whorls slightly convex, flatter in the middle, with a narrow band around it; nearly smooth." It is very seldom that any of the shell remains, and the descriptions of this shell have been all drawn up from decorticated specimens. When perfect, the keel or band and the surface are marked by longitudinal striæ.

Locality—Derry, *Tamlaght;* abundant in the white and also in the green chalk.

PYRULA *rapulum*—(Sowerby, MS.)

" Pear shaped, ventricose; last whorl including the others; columella thin, spire slightly protruded."

Locality—Derry, *Tamlaght*.

CASSIS *Avellana*—(Cuvier and Brongniart).

Mr. Sowerby considers this the species described by Cuvier and Brongniart, by Mantell and by Woodward, but not the species so called in " Min. Conc." He adds that it is also found in the upper chalk of Kent.

Locality—Derry, *Tamlaght*.

EMARGINULA ? *cancellata*—(Portlock).

Form obliquely conical, like a Capulus; vertex bent backwards, the posterior side being concave above and the anterior convex; section of base elliptic, the longer axis being ·6″, shorter ·4″, and the height ·5″. A broad flat furrow, which is keeled in the middle, proceeds from the vertex to the under and posterior margin. The shell is reticulated in quadrangular divisions by curved longitudinal costæ and concentric striæ. So strongly does this shell resemble Fissurella de Buchii (Geinitz), that I have used with little alteration that author's words. Our shell, however, has no aperture at the apex, which in one specimen is quite perfect. His species was from the conglomeritic bed of the Tunnel of Oberau."—(Petrefacten des Sächsischen Kreideberges).

Locality—Derry, *Tamlaght*. It is remarkable that these curious and similar shells should be found under such similar circumstances.

SILURIAN.

CONCHIFERA.—In this extensive class it is probable that the Silurian fossils approximate in form more closely to those of succeeding epochs than in either of the preceding; and yet, when considered as a whole, the Conchiferous Mollusca support and strengthen the character of individuality of the system. Amongst its numerous genera Inoceramus is remarkable as having been first recognised as a chalk fossil, and in some of its species, considered characteristic of that formation; it was then traced into the Oolitic and Carboniferous systems, and finally into the Silurian, although not as yet recorded in that system in England.

INOCERAMUS *trigonus*—(Münster)—Plate XXXIII., fig. 4.

Beiträge, 1840. Taf. X., fig. 3.—"Long, almost three-sided, much depressed; the flattened arch strongest at the beak. Between irregular concentric wrinkles are fine concentric striæ; the hinge line extended very much downwards, is half as long as the shell, which is broadest at the end of the hinge line. The tolerably sharp beak is arched backwards towards the hinge line." Though the state of the surface of the only specimen (a cast), is not such as to admit of distinguishing striæ, all the more important characters of the shell described by Münster are present in that here figured. The shell generally is flattened, but arched over abruptly at the anterior end, whilst it expands out at the other. The beak bends over and is quite close to one end of the hinge line, which is quite straight and greatly lengthened downwards. Though not quite perfect, the length appears to be 2·12 inches, and the length of the hinge line 1·25″, whilst in Count Münster's figure the dimensions are 2·5″ and 1·5″. His figure also does not show so distinctly the very straight hinge, but it is evidently drawn in a somewhat different position. His locality is "the light grey transition limestone near Presseck, where it occurs almost twice as large as the example figured."

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 2, associated with the Polyphemopsis.

INOCERAMUS *contortus*—(Portlock)—Plate XXXIII., fig. 5.

Long; hinge line short; the whole shell much arched, and the beak incurved, producing a twisted appearance; marked by fine concentric wrinkles and striæ. Length about 2″, hinge line ·6″.

Locality—Tyrone, *Desertcreat.*

INOCERAMUS *transversus*—(Portlock)—Plate XXXIII., fig. 11.

Generally flattened, but more convex and arched towards the beak end. Beak indistinct, and close to one end of the hinge. Hinge very long and straight; faint, nearly concentric waves. Length of hinge, if perfect, 2·75″, and greatest height of the shell, supposing it resting on the front of the valves, 1·5″. The strong resemblance of this shell to Inoceramus Cripsii of the chalk is deserving of notice.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 6.

INOCERAMUS *vetustus*—(Sow.) Var. *priscus*—Pl. XXXIII., figs. 1, 2, 3.

" Ovate, convex, smooth, regularly undulated; valves nearly equal; beaks short, pointed, curved; a concave space in the anterior side resembling a large lunette: hinge line short. Very regularly arched and gradually rising undulations of a smooth surface distinguish this from I. Brongniartii, independently of the difference in the anterior side. Hinge not seen, but the line to which it is attached is short; the front is very round."

The anterior lunette above mentioned not distinct in our specimens, though it may possibly have existed in the large specimen. The three figures show the form of the shell at various periods of growth; in fig. 3, it is almost uniformly rounded in front, and has a triangular aspect; in fig. 2, one side is more elongated than the other, and the waves are stronger; in fig. 3, which is 3·25″ long, the shell is more elongated, the beak more distinct, and the waves wide and strongly marked. This specimen more particularly resembles Sowerby's larger figure. Notwithstanding the striking resemblance of these specimens to Sowerby's figures and description, I am inclined to doubt their identity, and I have therefore, for the present, separated them as a variety; the distinguishing characteristic being the angle at which the hinge line and anterior margin meet. In Sowerby's species the angle is more than 90°, in this less. Professor Phillips observes, " it probably does not belong to Inoceramus (Sowerby), but to Posidonia (Bronn);" and his remark is probably correct in respect to the mountain limestone species, or at least to a portion of the specimens ascribed to it, as some of them, such for example as the Culcagh specimens, cited by Phillips in his localities, have all the characters of the genus Posidonia. Those however, now described, may fairly be considered Inocerami.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 6.

POSIDONOMYA—(Bronn).

This genus, in the form of some of its species, so closely approximates to Inoceramus, that Count Münster observes, in describing his

Posidonomyæ, that he should have been disposed to join them to Inoceramus, had he not found traces of the hinge furrows in the latter and none in the former. The hinge extends in a straight line past the beak in Posidonomya.

POSIDONOMYA ? *venusta*—(Münster)—Plate XXV., fig. 4.

" Several varieties of this rather small species occur, and may probably, as well as some others, belong to the genus Avicula. It has a transverse oval form, and is sometimes straight, sometimes oblique, sometimes with and sometimes without concentric wrinkles. There are fine irregular concentric, but no longitudinal striæ. The large rear is more or less separated from the rest of the shell by a slight bend. The short umbo projects a little over the ear." From the Clymenien limestone of Schübelhamer. Count Münster also remarks that he has seen the same species from Dudley.

The specimens I refer to this species are small, a quarter of an inch in length, are rather wider than long, somewhat more bent than in Count Münster's figure, and marked by fine irregularly concentric striæ. This shell is confined to the single locality so remarkable for the profusion of its Graptolites, and assists, therefore, in marking it out as a distinct zoological bed, in the Silurian schists.

Locality—Tyrone, *Desertcreat*. Sheet 37, No. 18.

MODIOLA *Nerei* }—(Münster)—Plate XXXIII., fig. 10.
MYTILUS ? *Nerei* }

Beit., 1840. Taf. XI., fig. 14.—This remarkable shell is between three and four times the natural size of the one figured by Count Münster; but its peculiar form recalling the idea of a Bullæa cannot be mistaken. It is thus described:—" The thick shell of this small neat Mytilus is longitudinally oval, highly arched, and having something like sidewards projecting beaks. The hinge is straight and the wider side falls almost perpendicular; the shell is regularly and concentrically striated." Some parts of this description, drawn up from a very small individual, require modification. The form is longitudinally oval. The surface is moderately arched, and the projection near the umbo, which produces a winged appearance, strongly resembling a Bullæa, is very striking. It is finely, concentrically striated, and a very neat shell. This and another species should probably be formed into a distinct genus. It is associated with other shells from the " Clymenienkalk," but Count Münster has omitted to give a distinct locality for it.

Locality—Tyrone, *Desertcreat*. Sheet 37, No. 6.

In the "Silurian System" two remarkable shells are figured, Avicula orbicularis and A. obliqua, which, in external form, approximate to some of the Tyrone species which are here referred to the genus Modiola. Avicula orbicularis is one of our fossils, A. obliqua is doubtful, and there are then several gradations in form which tend to those figured and now to be described.

MODIOLA *expansa*—(Portlock)—Plate XXXIII., fig. 6.

This shell is divisible into two varieties, one being less elongated in a transverse direction than the other, and approaching, therefore, to the form of Avicula obliqua. Front produced considerably beyond the beak, the portion anterior being to that posterior as 1 to 3, or 1 to 3·5; hinge line straight and equal in length to about one-half of the posterior section of the shell; anteriorly rounded and narrowed, posteriorly expanded and with an oblique curved truncation; a diagonal rise or pseudo ridge, from the beak to the lower posterior margin, which is more or less visible, as some of the specimens are more flattened than others. In this specimen, which may be taken as the type of the longer (wider) variety, the dimensions are, from the front to the lower posterior margin 2·12″, height or greatest width ·97″. In the smaller variety, from front to posterior margin 1·25″, height or greatest width ·84″. Surface quite smooth or occasionally with faint lines of growth. Sometimes the shell is even more elongated than in the figure, and sometimes drawn in below the beak, so as to form an obscure lobe.

Locality—Tyrone, *Desertcreat*. Sheet 37, Nos. 5, 6.

MODIOLA *securiformis*—Plate XXXIII., fig. 8.

The front is in this species still more produced than in the last, the proportion of the shell in front of the beak to that behind it being about 1 to 2; much narrowed and rounded in front; expanded and rounded behind, but without the oblique truncation. Oblique pseudo ridge from the beak to the posterior margin. This shell is partly distorted by pressure, but the regular increase of breadth from the front almost to the posterior margin is characteristic, and gives it, when viewed on its side, a wedge or axe-like form. Greatest transverse length 1·19″, greatest height ·7″.

Locality—Tyrone, *Desertcreat*. Sheet 37, No. 6.

MODIOLA *Brycei*—(Portlock)—Plate XXXIII., fig. 7.

Portion in front of beak to that behind as 1 to 7. Attenuated and rounded in front. The hinge line is extended farther behind than in M. expansa; the diagonal ridge is more strongly marked, and the shell is less expanded posteriorly, and more accuminated anteriorly. All the specimens of this shell, which, unlike M. expansa, generally occur in pairs, are somewhat crushed by pressure, which renders the diagonal ridge more distinct than it naturally would be. Transverse length 2·19″, height (length) ·75″, and allowing for distortion it is a narrower shell than the preceding. Smooth surface with faint traces of lines of growth. This is a more elongated shell than M. Nelsoni (Hisinger), but in the younger individuals approximates more to it than to M. antiqua (Münster).

Locality—Tyrone, *Desertcreat.*

It is dedicated to Mr. James Bryce, of Belfast, so well known as a zealous geologist; the author of the Paper on Portrush, and of several other Papers connected with the Geology and Fossils of the North of Ireland.

MYTILUS *cinctus*—(Portlock)—Plate XXV., figs. 5, 6.

In form the medium sized specimens strongly resemble Count Münster's Mytilus obliquus, which is thus described: "acutely oval, smooth, distinguished by a somewhat obliquely curved outline; the back is on the bent side highly arched, and falls off flat to the straight side. From the Clymenienkalk of Geiser." In size the smallest of our specimens are twice as large as Count Münster's. They exhibit considerable variation in form, being more elongated in some specimens than in others, and also sometimes twisted or distorted. Towards the beak it is more or less bent back from the curved to the straight side, which gives young specimens, in which this peculiarity is at its maximum, something of the appearance of a half-closed or drooping wing. Fine thread-like striæ proceed from the apex, first straight, and then curving over the back concentrically to the rounded front, proceed straight up to the bevelled line of the apex, or upper line of the wing. With age the winged character is gradually lost and the shell becomes elongated as in fig. 6; but the fine elevated threads continue characteristic of the species. I had originally intended to designate this species from its winged character, but as that is lost with age the name is given in reference to the fine threads. The largest figured specimen is 2·5″ long, the smallest 1″.

Locality—Fermanagh; abundant in the Lisbellaw schists, and in the young state rare in the Tyrone schists. Sheet 37, No. 18.

CYPRICARDIA ? *simplex.*

This approximates very closely to C. impressa (Murch.), but is without the concavity on which that name has been established. The beak is wrinkled on the anterior side; it is otherwise smooth, and in form the same as C. impressa.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 2.

Arcacea.

In the "Silurian System" three species only of this family are recorded as Silurian, and three more as belonging to the old red sandstone. Professor Phillips (Palæozoic Foss.) and Mr. Sowerby (Geo. Soc. Trans.) have added seven to the number, and yet it is remarkable that, although fossils of this family are abundant in the Tyrone schists, not one species can be satisfactorily identified with those previously described. Of the generic divisions, it may be also remarked that notwithstanding their number, some further subdivision will probably be found necessary in order to reduce the fossil and recent forms into more definite groups; for example, several of the Silurian species which approximate to the genus Arca in the character of the hinge line, are remarkable for a regular oval form, smooth surface, and slight arching of the line of teeth, and appear to form links of connection between the genera Arca, Nucula, Pectunculus, and Cucullæa. With these observations, however, this part of the subject will for the present be left.

Arca *sub-truncata*—(Portlock)—Plate XXXIV., fig. 1.

Beak nearly central in respect to the total transverse length of the shell, but as one end is slightly truncated, the beaks are rather nearer to the truncated than to the rounded end. General form, convex and oval, rounded anteriorly, truncated very slightly posteriorly; hinge line not quite straight, and the line of teeth slightly arched. The beaks are distinct, but there is not a marked area between them and the hinge line. Teeth, twenty exposed on one side of the beak, on approaching which they diminish in size; on the other side they are only faintly visible, and do not extend so far. Transverse length ·7″, height ·46″. Surface smooth.

Locality—Tyrone, *Desertcreat.*

Arca *regularis*—(Portlock)—Plate XXXIV., fig. 2.

Beak central. General form depressed and oval, or nearly semi-circular, the terminal angles being rounded off. Hinge line straight, but the line of teeth, which are not very distinct, has a slight arching. Length ·54″, height ·37″. Surface smooth.

Locality—Tyrone, *Desertcreat.*

Arca *Eastnori ?*—(Murchison)—Plate XXXIV., fig. 3.

Beak nearly central; general form slightly convex and transversely oval; hinge line very slightly arched; eight teeth visible on each side of the beak and many smaller between them. The beak sufficiently raised to have a distinct though small area between it and the hinge line. Length ·6″, height ·37″. Surface smooth. This has so much resemblance to Arca Eastnori (Murchison), the proportions in that shell being ·94″ to ·56″, or very nearly the same, namely, in the one as 1 to ·61, and in the other as 1 to ·59; the reference, however, must be confined to Murchison's Pl. 20, fig. 1 a, as the casts represented in fig. 1 b, if really belonging to the same species, appear to indicate a more convex shell.

Locality—Tyrone, *Desertcreat.*

ARCA *transversa*—(Portlock)—Plate XXXIV., fig. 4.

Beaks central, or nearly central: form, moderately gibbous and transversely oval, with obsolete truncation at the end. Hinge line slightly curved. Teeth numerous and fine, especially those below the beak. Scar of mantle distinct on the figured specimen. Length ·7″, height ·34″; surface smooth. Distinguished from the preceding species by its greater transverse length, the proportions being as 1 to ·49, by the slight truncation of the ends, and by the greater number and fineness of the teeth.

Locality—Tyrone, *Desertcreat.*

ARCA *cylindrica*—(Portlock)—Plate XXXIV., fig. 9.

Beaks, near the anterior end. Form convex, transversely elongated and cylindrical, anteriorly rounded; posteriorly obliquely truncated. Teeth nearly in a straight line, tolerably strong, and principally visible behind the beak. Deep impression in front of the beak. Length ·8″, height ·31″. Surface smooth. This transverse, convex, uniformly rounded shell, becomes, when the valves are closed, in some degree cylindrical.

Locality—Tyrone, *Desertcreat.*

ARCA *dissimilis*—(Portlock)—Plate XXXIV., fig. 5.

This shell diverging so strongly from the typical character of the hinge of the genus, I have given it a name indicative of that circumstance. Beaks near the anterior end. Form convex, obliquely oval, narrow in front, more expanded behind, anteriorly rounded, posteriorly rounded, with a slight oblique truncation; hinge line straight; teeth oblique to the hinge line, those behind the beak in a very slightly curved line, those in front few; if the two sets are really distinct, the lines would meet at an obtuse angle, but it is more probable that they are united together in a continuous curve below the beak. The species approximates in this arrangement of the teeth to the genus Nucula. Strong impression in front of the beak. Length ·47″, height ·37″; length in oblique direction of axis ·44″. Surface smooth.

Locality—Tyrone, *Desertcreat.*

ARCA *obliqua*—(Portlock)—Plate XXXIV., fig. 6.

Beak near one end. Form obliquely and transversely oval, rounded in front, behind rounded with an oblique truncation. Hinge line straight. Teeth strongly marked in the posterior portion, and only slightly oblique to the hinge line. The axis of obliquity forms an angle of about 30° with the hinge line. Anterior impression very strong. Length ·7″, height ·4″; length of axis ·62″. Surface smooth. The obliquity of this shell readily distinguishes it from all excepting the last, and it is distinguished from it by its much greater transverse elongation, producing a still more oblique form.

Locality—Tyrone, *Desertcreat.*

The three preceding species appear to form a very distinct group, characterized by the anterior position of the beaks, by being rounded in front and truncated behind, by the teeth being more or less oblique to the hinge line, and principally developed in the posterior portion, and in internal casts by the strong impression in front of the beak. They do not appear to be correctly referrible to any existing genus, and I would, therefore, suggest a name connected with the great posterior development of the teeth, those in front being comparatively very few.

The two next species approximate to the genus Pectunculus, having a distinctly arched hinge line, and orbicular form; the first of them, however, seems, like some of those which have been associated with Arca, to diverge from the ordinary type of the genus.

PECTUNCULUS *semi-truncatus*—(Portlock)—Plate XXXIV., fig. 7.

Beaks nearly central; form nearly orbicular, but with a slight obliquity, moderately convex, anteriorly and posteriorly rounded, but with a slight oblique truncation behind. Teeth rather large, arranged in a curved line which extends only a short distance behind the beak, but is more exposed in front of it. Length ·62″, height ·37″. Slight depression at the margin. Surface smooth.

Locality—Tyrone, *Desertcreat.*

PECTUNCULUS *Apjohnni*—(Portlock)—Plate XXXIV., fig. 8.

Beaks central and prominent; form convex and orbicular; hinge and teeth lines gently but distinctly arched. Teeth rather more numerous behind than before the beak. Length ·6″, height ·58″. This very well marked species I have dedicated to Professor Apjohn, the late President of the Geological Society of Dublin, and the Professor of Economic Geology to Trinity College, Dublin; it wants the crenulated margin of P. lens (Hisinger).

Locality—Tyrone, *Desertcreat.*

NUCULA *acuta ?*—(Sow.) VAR. *imbricata*—Plate XXXIV., fig. 10.

" Transversely ovate, convex, concentrically striated, anterior extremity rounded, posterior extremity produced, pointed. Length 1½ lines, width 2½ lines ; an elegant small shell." This description and Mr. Sowerby's figures (Geol. Trans., 1840. Plate XXIX., fig. 5,) so closely agree with our specimen that it is difficult to separate them ; still, however, it is probable that they are not the same. The length of our specimen is ·22″, height ·12″ ; the beak is rather more central and the shell is not quite so sharp. The striæ are also stronger, producing an imbricated appearance. I class it as a variety of Sowerby's species the resemblance being very striking. The upper figure is of the natural size, the lower magnified. Mr. Sowerby's fossil is from the Coalbrookdale coal field.

Locality—Tyrone, *Desertcreat.*

NUCULA ? *radiata*—(Portlock)—Plate XXXVI., fig. 11.

Beak about one-third from the anterior end. Form transversely oval and carinated ; anteriorly rounded, posteriorly attenuated or rostrated ; a sharp oblique ridge extends from the beak to the posterior margin bounding a bevelled space between it and the posterior hinge line. This space is marked by numerous raised thread-like striæ which radiate from the beak ; the remaining surface is smooth. Length ·75″, height ·47″. A very well marked shell, but as teeth have not as yet been discovered it can only be allocated here from its form, which corresponds to that of the rostrated species.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 6.

PECTUNCULUS ? *ambiguus*—(Portlock)—Plate XXXIV., fig. 11.

This shell is of uncertain character, no teeth having been discovered. Beaks central; form very depressed and orbicular. Hinge line straight and shorter than the transverse length of the shell. Front and ends uniformly rounded. Surface smooth with very faint lines of growth. The straight hinge line induces me to place this doubtful shell in the family of Arcacea.

Locality—Tyrone, *Desertcreat.*

MYTILUS ? *semi-rugatus*—(Portlock)—Plate XXV., fig. 7.

This has a resemblance to Pinna inflata (Phillips), but so far as can be judged from the specimens, none of which are quite perfect, the beak is not perforated or truncated. As one of the few fossils of the Fermanagh Silurian schists it could not be passed over. Wide, rudely trigonal; beak sharp; front wide, and usually more or less twisted or distorted; for about one-third of the length from the beak transversely wrinkled; longitudinally striated or very finely costated. In some specimens the shell is much more contorted or arched, like some of the contorted Aviculæ.

Locality—Fermanagh, *Lisbellaw.*

CARBONIFEROUS.

PTERINEA (Goldfuss). "Equivalve, inequilateral; winged at both sides, the anterior wing short, the posterior one expanded and more or less lengthened. Hinge line more or less oblique, linear, ligamental area internal. Beaks near the anterior end and often much elevated. The axis generally forms with the hinge line an acute angle."

PTERINEA *Thompsoni*—(Portlock)—Plate XXV., fig. 10.

A small species. Anterior wing short and sharp; posterior falcate and prolonged in a spine. Hinge line quite straight, one-third of its length, exclusive of the spiniform prolongation, being in front of the beak. The axis forms with the hinge line an angle of about 35°, and the shell is convex or swollen in its direction. The outline is, with a slight contraction, below the anterior wing, nearly straight from the frontal point of the hinge line to near the axis, then uniformly curved round the end of the axis, and finally ending with a recutering curve at the hinge line, the posterior margin therefore being sigmoidal. There is a slight rise parallel to the hinge line. Length ·7″, height ·22″. Surface of casts smooth with faint lines of growth. So far as can be judged from the specimens this shell is equivalved, and I place it, therefore, in Pterinea. P. lævis (Goldfuss) is a more expanded shell, and has not a falciform posterior wing; Avicula gracilis (Münster) is much more lengthened in the line of the axis. I have dedicated the species to William Thompson, Esq., of Belfast, who has so ably and indefatigably illustrated the Fauna of Ireland.

Locality—Fermanagh. Sheet 18, No. 3, smooth non-calcareous shale.

MODIOLA.

In fossils it is sometimes impossible to determine with certainty the limits of this genus, and it is, therefore, by no means improbable that some of the species which have been classed with Avicula do really belong to it, which is perhaps the reason why the genus, as recorded, is so rare in the more ancient strata of Great Britain and Ireland. Those species I am now about to describe are of peculiar interest as occurring in great abundance in peculiar shales, and having been traced from Derry by Tyrone into Fermanagh. The mode of their occurrence is also sometimes remarkable, as amidst the great mass of grits of the County of Derry they appear and disappear with the shales, thus affording an interesting proof of the necessity of noticing the nature of the mineral deposit in connection with the history of the animals which lived in or upon it. The three forms figured, Pl. XXXIV., figs. 13, 14, 15, seem in themselves sufficiently distinct for specific separation; but there are so many intermediate gradations, and so much variation from age and the condition of the specimens, that I shall unite them together as merely varieties of one species, which I dedicate to Mr. James MacAdam of Belfast, who, aided by the skill of Mr. Doran, our former collector, was enabled to trace the curious shelly deposit containing this fossil, and the large scales of Holoptychius Portlockii (Agassiz), to the shore of Hollywood, near Belfast, where it appears to rest on the ancient transition schists and to underlie the supposed magnesian limestone. Though not, therefore, the discoverer of the species, he has at least added to it a most interesting and important locality.

Modiola *Macadamii*—(Portk.) Var. *angusta*—Pl. XXXIV., fig. 13.

Lengthened, narrow, and convex, having therefore a somewhat cylindrical appearance, though it is wider behind than before. Beaks not distinct, and near the anterior end. Rounded in front, and behind with a slight obliquity in the posterior margin. Hinge line straight but not distinct. Surface, when perfect, marked with fine concentric threads. This diverges as much from the ordinary form in one direction as fig. 15 does in another.

Modiola *Macadamii*—(Portk.) Var. *elongata*—Pl. XXXIV., fig. 14.

Elongated; rounded before and behind with a distinct obliquity of the posterior margin. Hinge line straight and equal to about half the length of the shell. Surface marked with fine raised thread-like striæ. This approximates to M. lingualis (Phillips).

Modiola *Macadamii*—(Portk.) Var. *lata*—Pl. XXXIV., fig. 15.

Rounded in front, expanded and depressed behind, with a distinct posterior obliquity. Hinge line straight, and exceeding one-half the length of the shell. Surface wrinkled in front and at the beak, and showing by remaining fragments that the shell was originally marked with concentric thread-like raised striæ. The flattened form is probably the result of pressure, as it is rare; and the ordinary form exhibits a more distinct rise or rounded ridge from the beak to the posterior margin and is narrower. Though not unlike some of the forms of Avicula Damnoniensis, this shell has no radiating striæ, &c.

Localities—Derry, *Ballynascreen;* Tyrone. Sheet 58, No. 3, &c.

MODIOLA *sub-parallela*—(Portlock)—Plate XXXIV., fig. 16.

Convex, rounded, tolerably wide and wrinkled in front, with a slight contraction from the beak to the margin, forming an obscure anterior lobe. Diagonal rise from the beak to the posterior margin not constituting a ridge; rounded behind with a very slight obliquity or truncation. Hinge line and front nearly parallel. Surface, when perfect, marked by thread-like concentric striæ, not quite regular, but partaking at the beak of the twisted character so usual in the genus. Though this appears so very distinct a form from M. Macadamii, I am disposed to think that they all merge one into the other; but for the advantage of distinguishing the shell in other localities I have separated this variety, so strongly marked, as a distinct species.

Localities—Derry, *Ballynascreen*: Tyrone, &c., in shale.

SANGUINOLARIA.—This is evidently a very doubtful fossil genus, the relations of its species to the recent shells being by no means satisfactorily established; the group may, however, be admitted as at least useful. The first species is intermediate in its characters between S. angustata and S. sulcata, being proportionally less narrow and more strongly sulcated than the one, narrower and less rounded than the other.

SANGUINOLARIA *plicata*—(Portlock)—Plate XXXIV., fig. 18.

Narrow, depressed, transversely elongated; length to height as 1·6″ to ·6″; rounded anteriorly and posteriorly with a slightly oblique truncation. Beak near the anterior end; faint rounded ridge from the beak to the posterior angle. Hinge line straight, with a slight depression or furrow below it, as is seen more strikingly in the next species, fig. 20. Furrows, better expressed by the term folds, parallel to the margin, and, therefore, rounding over the diagonal pseudo-ridge, and then proceeding nearly straight to the hinge. It is seldom that the specimens are so perfect as that figured, and when less so, they approximate more in appearance to S. angustata; but the beak is not so much advanced in that species; to guard, however, against the errors of figures, it may be stated that the distance in front of the beak is to that behind it as 1 to 4, and sometimes 1 to 6.

Locality—Tyrone, *Benburb*.

The form of this shell admits of considerable variation:—1. The more rounded form approximates to S. sulcata, but without such deep and wide furrows. Derry, *Ballynascreen*, in the black bituminous-looking Modiola shale. 2. The plicæ much finer near the beak, producing an imbricated appearance. Derry, *Desertmartin*. Sheet 41, No. 74, in clay-like shale.

Sanguinolaria *undata*—(Portlock)—Plate XXXIV., fig. 20.

Transversely elongated and narrow; hinge line quite straight; a deep impression or furrow extends from the beak to the posterior margin, it is below and nearly parallel to the hinge line. The folds or furrows are wide and like waves on the surface; those near the beak bent over the line of the usual diagonal ridge at an acute angle, but towards the posterior end becoming rounded. The fragment of this curious soleniform shell differs essentially from any of the approximate species, as it is more transverse than S. sulcata, and in its folds differs from S. plicata and S. angustata.

Locality—Tyrone, in shale.

Sanguinolaria *transversa*—(Portlock)—Plate XXXIV., fig. 21.

Transversely elongated, depressed, and narrow; transverse length to height as 3·3 to 1, the length being 3·75 inches. Rounded in front, slightly truncated behind. Beaks near the front, the distance anterior being to that posterior as 1 to 4. Hinge line straight. Diagonal ridge slightly marked. Concentric undulations and lines which are very slightly marked. This is as much depressed as S. plicata and resembles it in form, but the undulations or folds become little more distinct than the ordinary lines of growth.

Locality—Fermanagh. Index, No. 5, in a calcareous grit; and No. 7, in shale.

Sanguinolaria *oblonga*—(Portlock)—Pl. XXXVI., fig. 2.

Transverse length 2·06″. Height 1·47″. Depth of one valve ·59″, or of both 1·18″. Beaks close to one end. Ends almost straight or square; very slight curve of the lower margin, which, diminishing with age, adds to the squareness of the outline. Concentric plication and striæ, but not strongly marked on the specimen. This differs from S. sulcata by being more gibbous, and squarer in its outline.

Locality—Tyrone, *Errigle Keerogue*. Sheet 59, No. 11, in black limestone; a characteristic shell.

Sanguinolaria *maxima*—(Portlock)—Pl. XXXVI., fig. 1.

Unfortunately, this remarkable specimen is only a fragment. Transverse length of fragment 3·75″, height 1·9″, depth of the two valves taken together 1·75″; beaks close to the end; hinge line and margin quite parallel, concentrically plicated or furrowed and striated. A gibbous, elongated, and squared shell.

Locality—Tyrone, *Donaghenry*. Sheet 39, No. 12, in light-coloured gritty limestone.

SANGUINOLARIA ? *attenuata*—(Portlock)—Pl. XXXVI., fig. 3.

Rude casts occur in the grits of Errigle Keerogue, Sheet 52, No. 10, which are not unlike Goldfuss' S. soleniformis in outline, but have no diagonal ridge. They are rounded before and behind, and instead of being truncated they are posteriorly attenuated. One specimen shows the lines of transverse plaits. Doubtful fossil.

PECTEN.—It is very remarkable that this genus has not as yet been shown to have existed at the Silurian epoch, in either Great Britain or Ireland.

PECTEN *plicatus*—(Sowerby).

The ribs are usually alternately small and large, but all are fine. The ears are not so large as in P. papyraceus, are more separated from the sides, and are strongly ribbed, the ribs being slightly crenulated by concentric lines of growth. All the specimens are small, ·75″ long, and variable in shape, being sometimes longitudinal, sometimes transverse. This is evidently not P. plicatus (Phillips), in which neither the ribs are so distinctly alternating nor the ears smooth.

Locality—Tyrone, *Errigle Keerogue.* Sheet 59, Nos. 52, 59. Fermanagh. Index, No. 17, in smooth shale.

PECTEN *interstitialis*—(Phillips).

This Pecten has not been sufficiently figured or described. About six of the radiating ribs are more prominent than the others, and rise into rough points at short intervals of growth. The space between them is subdivided by another set of somewhat less strength, and the lesser spaces are occupied by three finer ribs. All the minor ribs are rough, though not so much so as the larger set. Portions of the shell are preserved on the ribs.

Locality—Tyrone ; Smith's Quarry, near Dungannon, in a shaly limestone.

PECTEN *arenosus*—(Phillips)—Var. elongated.

" Radiating striæ very numerous, alternately larger ; minutely crenulated with many sharp circular striæ." In addition it is stated that the shell is a quadrant of a circle with rather short square ears ; but these characters are not preserved in large individuals. The spaces between the ribs not so large as in the next variety.

Locality—Fermanagh, *Drumkeeran.* Sheet 5, No. 27, in shale.

Small variety, in which the ears are slightly rounded ; the small intermediate costæ or thread-like ribs extend only about two-thirds from the margin towards the beak. The impressions of these shells might be mistaken for another species, as the spaces between the larger costæ look like broad flat ribs with a groove running up their middle, which is the impression of the smaller rib.

Locality—Fermanagh, *Enniskillen*. Sheet 18, No. 3, in shale.

PECTEN *granosus* (Sow.) Var. PECTEN *Ottonis ?* (Goldfuss) Var.

It is difficult to compare a very small with a tolerably large shell, as in the present case, where the specimen figured by Goldfuss was only ·31″ long, and our specimen is 1·26″ long; but there is so much correspondence in the general characters as to render it desirable to bring them at least under comparison. "Sub-orbicular, sub-convex, oblique, with radiating lines decussated by concentric striæ; ears unequal, the anterior acute, the posterior rectangular." It is added that many of the radiating lines do not reach to the middle of the back. The shell before us may be thus described: Numerous, small, but distinct ribs, the number exceeding forty, which are sinuously crenulated by concentric striæ, closely set together. The ribs are occasionally irregular, and some of them do not extend much more than half way up to the beak. The front ear rather sharp, radiated by costæ, and concentrically striated; posterior ear nearly square, one valve convex, the other flat-convex, both orbicular with very slight obliquity. Differs from P. granosus (Sowerby) by having all the costæ equally crenulated; from P. fimbriatus (Phillips), by more numerous ribs, and by having radiated and rather large ears.

Locality — Fermanagh, *Drumkeeran*. Sheet 1, No. 5, in grit. Goldfuss' locality. In Psammite, greywacke of Glatz, in Silesia.

PECTEN *semicostatus*—(Portlock)—Plate XXXVI., fig. 9.

Orbicular, convex; equally and numerously costated, the costæ smooth and not extending much more than half way towards the beak; ears nearly equal, the posterior square, the anterior rather more pointed. This may be only an internal cast, but provisionally it is desirable to notice it as distinct, being a characteristic shell.

PECTEN *plicatus*—(Phillips)—Var. without striated ears.

This occurs associated with the true P. plicatus, in a remarkable fossiliferous grit, spangled with specks of mica.

Locality — Fermanagh, *Drumkeeran*. Sheet 1, No. 5. It is probably only an accidental peculiarity, or rather the appearance of the internal cast, as the costæ seem flatter and less marked than usual: associated also with an Orthoceratite not specifically distinguishable.

PECTEN *ellipticus*—(Phillips).

"An oval, smooth, depressed species, with short ears." The specimens are moderately convex and quite smooth. The ears are very slightly marked, one being scarcely distinguishable from the lateral margin.

Locality—Characteristic of a remarkable siliceous bed. Tyrone, *Kildress.* Sheet 29, No. 66.

Pecten *ovato-costatus*—(Portlock).

This shell has the form of Pecten ellipticus, but is a little oblique. It is, however, marked by numerous equal costæ. The ears are very slightly marked, one being scarcely distinguishable from the side. The gritty surface will not allow of any determination of the nature of the costæ as to smoothness.

Locality—Tyrone, *Carnteel.* Sheet 60, No. 32, in grit.

Pecten *transversus*—(Sowerby)—Var.

"Transversely obovate, very slightly convex, radiated; radii in threes, crossed by numerous regular lines of growth; ears large and nearly equal. Length about one inch, width nearly one and a half. The great width of this shell is a prominent feature. Locality, Barnstaple." The shell here referred to this species may be thus described: Principal costæ duplex, or formed of two close together; a finer single costa between two sets of the double. Surface marked with very fine lines of growth not amounting to granulation. Length ·62″, width ·91″. These characters agree better with Sowerby's figure than with Phillips', and do not suit the description given by Goldfuss of his Pterinea radiata, in which "12 to 13 large costæ radiate from the beak, having, in the intervals between them, 2 or 3 smaller, the whole being marked by sharp, crowded, and regular concentric striæ." It may be added that some of the duplex costæ are occasionally smaller than the rest when the appearance is as if two or three smaller were between the larger.

Locality—Tyrone, *Errigle Keerogue*, in smooth shale. Sheet 52, No. 58.

Pecten *granosus*—(Sowerby)—Var. (Phillips).

Sowerby describes the species as having rough ribs alternating with *smooth*; Phillips' larger alternating with smaller, *both* being imbricated, and the general character of his shell is very different from Sowerby's.

Locality—Benburb; impressions of the flat valve in shale.

Pinna *flabelliformis*—(Martin). Var. *inæquicostata*—(Portlock).

Martin describes P. flabelliformis as having the surface "sulcated in a longitudinal direction, the sulci equal and straight, the intervening spaces rounded and smooth;" and Phillips, his P. costata as being equally costated *on the middle* of the valves. This species is elongated, on one side marked by numerous small sulci, separated by small rounded costæ; on the other by rather wider sulci, separated by wide, flat, and irregular costæ, the immediate sides of the cast being smooth. Length of specimen 4·5″, width at broad end 1·7″. The costæ are not quite straight but have a slight flexuosity towards the front.

Locality—Tyrone, *Carnteel.* Sheet 60, No. 35, grey limestone. *Benburb,* in ironstone, probably the same, but not a perfect specimen.

GERVILLIA ———. Casts.

These cannot safely be determined, though they resemble the specimen figured by Phillips as the cast of G. laminosa, but which appears to differ very strongly from the other figure of that species.

Locality—Tyrone, *Carnteel,* in ochreous spotted grit. Sheet 60, No. 32.

GERVILLIA *squamosa*—(Phillips).

"Arched, posterior side ridged; surface squamoso-striate. Bolland." Described by Phillips from a fragment. The specimens here referred to the species are also imperfect, but have the squamose or wide-plaited description of striation noted by Phillips. The diagonal rise from the beak to the posterior margin is not a sharp but a rounded ridge, and not equally marked in all specimens. This species should probably be classed with Avicula or Pterinea.

Locality—Fermanagh, *Enniskillen.* Sheet 18, No. 4, in shale.

GERVILLIA ? *elongata* ———. Casts.

These are larger than casts of G. laminosa, and have no retroflexion of the posterior margin. Length 1·4″; length of posterior hinge line ·53″. Shell slightly and variably arched. In G. inconspicua the hinge line appears longer; but our specimens would agree better with a cast of G. laminosa, such as Professor Phillips figures it, than the figure he gives of G. inconspicua.

Locality—Fermanagh, *Drumkeeran.* Sheet 1, No. 5, in grit.

VENUS ? *carbonaria*—(Sowerby).

"Obovate, convex; anterior side rounded; posterior side truncated, squarish; beaks rather prominent; shell most gibbous towards the beaks. Length one inch four lines, width one and a half inch. These casts have much the aspect of Mactræ; the hinge is unknown. Coalbrookdale." It is probable that the fossils here noticed should be placed either in Mactra or Amphidesma. Three forms occur closely approximating to each other, and as the several specimens exhibit considerable variation, they may prove varieties of the same species, I however adopt the name Amphidesma.

1st. Amphidesma carbonaria, Venus carbonaria ? (Sowerby) Plate XXXVI., fig. 8. Transverse length 1″, height ·9″. Beak nearly central, rounded anteriorly, truncated posteriorly, with a slight inflection of the margin below the truncation; the surface appears to have been concentrically finely striated. This is the variety nearest to Sowerby's species.

Locality—Tyrone, *Clogher*. Sheet 59, No. 67.

2nd. Amphidesma depressa. The general form the same, but the truncation is less marked and the shell less convex; this I propose to call A. depressa, or probably Mactra depressa.

Locality—Tyrone, *Clogher*. Sheet 59, No. 59.

3rd. Amphidesma axiniformis, Pl. XXXVI., fig. 6. More convex; beak rather nearer the front; truncation more distinct; less transverse.

Locality—Tyrone, *Clogher*. Sheet 65, No. 28.

Amphidesma *deltoida*—(Portlock). Cypricardia *deltoida*—(Ph.?)—Plate XXXVI., fig. 7.

Swollen, nearly orbicular; anteriorly regularly rounded; posteriorly sharply truncated; the diagonal ridge from the beak to the posterior margin a well defined angle. Phillips suggests of his species that it may be the young of Isocardia axiniformis, but such reference appears very doubtful.

Locality—Derry and Tyrone, in shale.

Nucula *undulata?*—(Phillips).

"Transversely ovate, depressed; with delicate concentric striæ; a ridge on the posterior slope. Bolland." In general form our specimen agrees with Phillips' figure; the ridge is obscure, but sufficient to separate the bevelled posterior surface. It has been finely concentrically striated; but undulation is not perceptible.

Locality—Tyrone, *Clogher*. Sheet 59, No. 54, in shale.

Nucula *lævi-rostrum*—(Portlock)—Pl. XXXVI., fig. 12.

Distance anterior to beak is to that posterior as 1 to 2; moderately convex, rounded in front, the margin descending in a curve to about one half the transverse length, then curving upwards; posteriorly narrowed and rounded, without any ridge or diagonal rise from the beak, marked by fine concentric striæ. The absence of any diagonal ridge and the curved posterior end are characteristic, and distinguish it from N. claviformis of Sowerby or of Phillips. In these particulars and in general form it has a strong resemblance to N. Münsteri (Goldfuss), a fossil ranging from the Muschelkalk to the Oolites, but is less transverse and less attenuated.

Locality—Armagh and Tyrone. *Benburb*, in shale.

Nucula *tumida*—(Phillips)—Var.

This shell exhibits some variety in its form. It is abundant in the shales which overlie the elevated limestone of Cullion, at the northern base of Slieve Gallion. Described as "gibbous, ovate, concentrically striated; beaks tumid." In this there is a slight narrowing in the front.

VENUS? *elliptica*—(Phillips).

"Oval, depressed with large transverse undulations." This appears more gibbous than in Phillips' figure and the genus is doubtful.

Locality—Armagh and Tyrone, *Benburb*, in shale.

PULLASTRA? *bistriata*—(Portlock). VENUS *elliptica*? (Ph.) Var., Plate XXXVI., fig. 13.

Oval, depressed, and imbricated with concentric striæ. Beaks near one end and not distinct; beautifully marked by two sets of lines, or striæ, crossing each other and obliquely the concentric striæ also; a very beautiful shell. The genus is doubtful, but it is placed here as nearest to some similar forms in the works of Mr. Sowerby and Professor Phillips; as specimens occur together exactly the same in form, some being striated and some not, I am disposed to think they belong to the same species, V. elliptica (Phillips).

Locality—Tyrone, *Benburb*, and *Aghaloo*. Sheet 60, No. 65, in shales.

ISOCARDIA *oblonga*—(Phillips).

The apparent young of this species, only ·37″ in transverse length, in the shale of Benburb; of the usual size in the Fermanagh limestone.

Locality—Fermanagh, in ochreous limestone.

PLEURORYNCHUS *minax*—(Phillips).

"Deltoidal; anteriorly gibbous, rounded, with a contracted subconcave cordiform space around the umbo; posteriorly, elongated, conoidal; beaks anterior, surface radiated with many equal ribs, except on the cordiform anterior space, where they are very much finer than on the other part, and are distinctly cut off by the carina which bounds the depression." The synonyms quoted are Sowerby's C. aliforme, Var. corresponding to the lower figure of his plate 552, and Goldfuss' C. aliforme, Var. γ; both those authors considering the several forms as merely variations from one leading one. In the specimen here figured the ribs, from the pseudo-carina to the commencement of the posterior conoidal elongation are equal and strong; on the under portion of the prolongation they are broader, on the upper narrower. On the cordiform hollow they are also smaller, and, as stated by Sowerby, "diverge from one of the longitudinal ribs on each margin of it." The peculiarities of both Mr. Sowerby's figures appear to have entered into his description, which perhaps has occasioned the doubts as to the individuality of the two species. The valves are gaping in the posterior portion of the shell, and the lines of growth are strongly marked. M. Agassiz remarks that the genus Conocardium, proposed by Bronn for the very curious shells placed in this genus, is well founded, that he has reason to believe that they should be even further removed from the genus Cardium than has been hitherto imagined, and that they are in many respects allied to the Brachiopoda. Mr. Lonsdale is inclined to place them in the Rudista.

Locality—Fermanagh, *Enniskillen*, in light coloured limestone.

Solemya *primæva*—(Phillips).

" Transversely elliptical, depressed, with radiating smooth striæ." Two specimens only of this remarkable shell have been met with.

Locality—Derry, *Desertmartin ;* Tyrone, *Aghaloo*, in limestone.

Solen *pelagicus ?*—(Goldfuss)—Pl. XXXVI., fig. 4.

Described as " transversely elongate, lancet-like, straight and rounded at both ends. The small beak behind the anterior end which is somewhat impressed, so that the under margin here makes a bend. A keel from the beak to the hinder margin." A coarse cast strongly resembles this shell in its transverse, narrow, lancet-like form, and the bevelled upper surface between the diagonal keel and the hinge.

Locality—Tyrone, *Clogher*, in gritty limestone. Sheet 57, No. 2.

Lutraria *primæva*—(Portlock)—Plate XXXVI. fig. 5.

Transverse length 2·5″ ; height 1·3″ ; beaks swollen and near the anterior end. Shell rather twisted from the beaks towards the posterior angle and diagonally tumid ; flattened posteriorly. The outline behind appears to exhibit a flattened curve ; not amounting to truncation. Surface marked by lines of growth and irregular concentric striæ becoming merely faint waves in the cast. This, in general aspect, resembles Unio Urii, as figured by Sowerby, but it is a flatter shell, and though crushed in the specimen, appears, when perfect, to have gaped.

Locality—Tyrone, *Carnteel*, in limestone. Sheet 59, No. 11.

Cypricardia ? *tricostata*—(Portlock)—Plate XXXIV., fig. 17.

The casts of this shell exhibit a deep incision in front of the beak—and though the genus is doubtful, I do not see that it can be better placed at present. Transverse length 1·9″ ; height ·75″. Moderately gibbous, rounded in front and behind, with an oblique pseudo-truncation. When quite perfect a strong diagonal rise, amounting to a ridge, from the beak to the posterior angle, and three other ridges, including the one which runs close to the hinge line, and bounds with a sharp keel the area between the beak and hinge. Surface marked by irregular concentric striæ. The ridges are sometimes not so distinct, and in casts either obscurely or not all visible. No teeth have as yet been discovered, though in form it approximates to the Arcacea. This is a highly characteristic shell of a particular bed, and is, therefore, a most important geological datum.

Locality—Tyrone, *Carnteel*; Fermanagh, *Drumkeeran*. Sheet 1, No. 10, in an iron-grey impure limestone, full of fossils, amongst which are small turbinated shells.

TRIGONIA? *incerta*—(Portlock).

An impression only of the costated portion of this shell. It was strongly ribbed and concentrically furrowed, so that the ribs must have appeared sharply tubercular.

Locality—Derry, *Maghera;* in a curious mud-like bed associated with the shales which contain the scales of the Holoptychius and spines of Gyracanthus.

INOCERAMUS *vetustus*.—Very probably, as conjectured by Phillips, a Posidonia, occurs in abundance in the elevated shales of Culcagh, and, therefore, above what is coloured by Mr. Griffith as the upper limestone: Professor Phillips' locality " Kulkeagh." This remarkable and characteristic shell is recorded in Mr. Griffith's list, as only occurring in the " Carboniferous slates " of the Northern District, or below the lower limestone; it occurs, however, in the shales of Benburb.

CRETACEOUS.

In addition to those species already referred to, and which will again appear, as well as others, in the Synoptical Table, may be mentioned as examined and determined by Mr. Sowerby, Astarte lenticularis: Arca radiata; " transversely sub-cylindrical, radiated; anterior slope defined by a ridge, the extremity of it pointed; posterior extremely rounded; beaks close."—(Sowerby's MSS.); a very remarkable shell, not rare in the Tamlaght glauconous chalk: a Venus and a Cardium. A remarkable Pholadomya also occurs, the surface of which although much worn, still exhibits *numerous* small costæ; the general form resembles Pholadomya Puschii (Goldfuss), which is represented as a fossil of the " Upper Marine"; it is, however, much higher, proportionately to its transverse length, than that species, or nearly as 3 to 4. It will, as well as the preceding species, be hereafter figured.

SILURIAN—BRACHIOPODA.

LINGULA.—In comparing specimens of Lingula it is necessary to keep in view two sources of apparent difference: age, as the breadth sometimes increases more in proportion than the length, and thus produces an augmenting squareness of outline, or *vice versâ ;* and the nature of the cast; that from an external mould being smooth and convex, whilst that from the inside is marked by a medial longitudinal furrow, corresponding to a central internal ridge in the shell, and is sometimes striated when the outside is not, and is further more rounded or less acuminated retrally.

LINGULA *attenuata*—(Murchison)—Plate XXXII., fig. 4.

" Depressed, smooth; front rounded; sides nearly straight; attenuated towards the apex. Length 7½ lines, width 5 lines." The specimens which I refer to this species possess its most striking characteristic, " attenuated towards the apex" in the highest degree. They are, however, longer in proportion to their breadth; in the specimen figured the length ·65 and the breadth ·31, but in another the difference is not so great. The front is rounded, the sides very slightly curved; the surface smooth and shining; the edges slightly flattened.

Locality—Tyrone, *Desertcreat*. Sheet 37, No. 18; dark slaty flag.

LINGULA *brevis*—(Portlock)—Plate XXXII., fig. 2.

Acuminated retrally, but quickly attaining the full breadth; sides sub-parallel. Front flat, rounded. Length to breadth 5 to 4. Surface flattened, smooth, and very faintly marked by lines of growth. This has a short wide aspect, but it may be the young of another species, the breadth not increasing in the same proportion as the length. Three specimens, all small, ·19″ long.

Locality—Tyrone, *Desertcreat*. Sheet 37, No. 2.

LINGULA *lata*—(Murchison)—Plate XXXII., figs. 1, 3.

" Obovate, squarish, flat, smooth; front edge truncated. Width about two lines, length three lines."

Murchison's specimen appears to have been a young shell, as the two (all found) here figured are much larger; the one, fig. 1, exhibits the external, and fig. 3, a cast of the internal surface. Of fig. 1, length ·62, breadth ·5. Smooth, flat, convex, shining and shelly. Form obovate; the truncation of the front being very slight. The inside cast has even a more rounded outline, and is also wider. There are faint traces of longitudinal striæ. The difference between this and Mr. Murchison's do not appear greater than may be considered referrible to age.

Locality—Tyrone, *Desertcreat*. Sheet 38, No. 176. Coarse schist, Sheet 37, No. 6.

CARBONIFEROUS.

LINGULA *squamiformis*—(Phillips)—Plate XXXII., figs. 5 a, 5 b, 5 c.

" Oblong, with parallel sides; truncate in front, acuminated retrally; a central oblong depression; surface with finely radiating and concentric lines. It does not quite agree with L. mytilloides of Sowerby." This shell varies considerably in the proportion of length to breadth, viz., 3 to 2, or even wider, corresponding to Professor Phillips' figure, and 2 to 1, nearly. The front is truncated, the angles being rounded off to the sides; sides parallel posteriorly, slightly acuminated, but not nearly so much so as L. mytilloides. When the surface is preserved it is in these shales black and shining, and marked by concentric lines of growth. The shell appears to have been very thin, and when removed there are faint radiating or longitudinal lines. Externally it was flattened towards the front, internally the casts exhibit the usual impression of the central internal ridge. Generally speaking it was a flat species; but some of the impressions are deeper than others, and show the concentric striation more distinctly. Lingula cornea (Murchison, old red sandstone,) closely approximates to this species, as also L. Lewisii (Murchison). Associated on the same specimen with scales of Holoptychius, and remains of small plants finely striated longitudinally.

Locality—Fermanagh, *Enniskillen*, in shale. Sheet 17, No. 5.

LINGULA *parallela*—(Phillips)—Plate XXXII., figs. 6, 8, 9.

Oblong oval; length ·37″, breadth ·22″ in a large specimen; rounded in front and rounded retrally; shell smooth, shining, and marked by very faint concentric lines of growth. No longitudinal striæ. In the larger specimens the shell is generally flat, with a slight mesial rise; in smaller it is uniformly convex, but it is also so in some of the larger; hence it is probable that L. marginata and L. parallela are the same species, a very slight alteration in the frontal curve producing the appearance of truncation. Fig. 6, exhibits a young individual adhering to the larger. Fig. 8 is a flattened variety which is probably equivalent to L. marginata; and fig. 9, is the more rounded form of L. parallela. None of these are internal casts, as it appears from part of the description of L. marginata by Phillips, " slight mesial ridge on a flat space; small oval hollow," that his specimen probably was; and this difference accounts for the absence of longitudinal striæ.

Locality—Tyrone, *Desertcreat*. Sheet 38, No. 156, in brown, highly calcareous shale; also *Clogher*, the same shale passing into limestone. Sheet 65, No. 23.

LINGULA *mytilloides ?*—(Sowerby)—Plate XXXII., fig. 7.

" Ovate; anterior end slightly truncated; beak indistinct." One specimen only of a very young individual obtained; moderately acuminated retrally, rounded anteriorly, convex. This is more acuminated at the beak than in the preceding species, and appears to differ from Sowerby's in the usual proportional variations of young and old shells.

Locality—Tyrone. Sheet 65, No. 23, dark, smooth, shaly limestone.

SILURIAN.

ORBICULA *lævigata ?*—(Münster)—Plate XXXII., figs. 11, 12.

"Circular; highest towards the beak which is only slightly arched, short, and at the outer margin depressed; the shell is smooth with scarcely visible lines of growth. Diameter ·3″, height ·1″, attached to an Orthoceratite. Locality—Elbersreuth." The specimens I refer to this species are of considerable size as compared with those of Count Münster, the diameter being in some ·75″, and there is no greater difference than age and varying circumstances might produce. It is difficult to clear the shell entirely from the matrix, but it appears to have been nearly circular, with the beak close to the margin, and a smooth shell. In fig. 12, the position of the beak, and its sunk form, correspond exactly to Münster's description, but the shell is rather less rounded; in fig. 11, the beak is more raised, but the form is nearly circular. These are only variations from circumstances and lead to the next species.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 6; gritty coarse schists, slightly calcareous.

ORBICULA *elongata*—(Portlock)—Plate XXXII., fig. 13.

Longer than wide, much flattened and smooth; beak very little raised and near to the margin, but not quite so close as in the last species. Length ·8″, breadth ·6″. Though it is almost impossible to expose the whole of these shells, some of the specimens appear too much elongated to be classed with the preceding. The beak is also less distinct and farther removed from the margin.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 6, gritty schists, not calcareous.

ORBICULA *sub-rotunda*—(Portlock)—Plate XXXII., fig. 10.

Slightly oval; length ·55″, breadth ·44″, though with some variation. Beak more removed from the margin than in either of the preceding species, the distance being equal to one-fourth of the diameter. It approximates to the Carboniferous species.

Locality—Tyrone, *Desertcreat.*

The shell is not preserved in any of these specimens.

CARBONIFEROUS.

ORBICULA *plana ?*—(Münster)—Var.

"Nearly circular outline, though somewhat broader than long. The upper shell is very flat convex, with a very short depressed beak situated on the outer margin. The shell is smooth with a few faint lines of growth; but passing round the margin is a concentric furrow by which it may be distinguished from the similarly flattened O. lævigata. Length ·3″, breadth ·35″. Locality, Schübelhammer." The peculiar groove mentioned by Münster is deficient in our specimens; but it is doubtful whether that character would amount to more than variation. In size our specimens are greatly superior; they may be described as nearly circular, but rather wider than long; length ·75″, breadth ·9″; smooth, the lines of growth very slightly marked; very much depressed. It closely approaches the Silurian species. Impressions are glossy, bituminous, but not strongly marked by concentric lines.

Locality—Fermanagh, in calcareous shale.

ORBICULA *nitida ?*—(Phillips)—Var. Plate XXXII, fig. 14.

" Oval, glabrous, finely radiated; lower valve flat, upper conico-lenticular, apex nearer the narrower end. The Coalbrookdale specimens are slightly more depressed than these of Yorkshire and Northumberland." Of the two varieties, if not species, here figured, the present one approximates nearest to Professor Phillips'. It is oval, glabrous, with rather irregular and faintly marked lines of growth, and under a magnifier fine radiating striæ can also be detected; the beak is distant about one-fourth of the diameter from the margin, and this distance varies in Professor Phillips' figures; it is tolerably elevated, the height being sometimes, as in the figure, nearly one-third of the diameter, but more generally about one-fourth. The only decided character in these specimens by which they can be distinguished from O. nitida (Phillips), is the comparative faintness of the radiating striæ, which almost become obsolete.

Locality—*Benburb,* in shale.

ORBICULA *cincta*—(Portlock)—Plate XXXII., fig. 15.

Nearly circular and marked by fine but distinct concentric lines of growth. Beak less than one-third of the diameter from the margin, and elevated also about a-third, being sometimes sharper than at others. Lower valve also raised, but truncated at the apex. The whole surface with a black bituminous gloss. It differs from Münster's O. subrugata by being more elevated and by the greater distance of the beak from the margin; and in a similar manner from O. rugata (Murchison) as well as by the fineness of the concentric striæ. Fig. 13 of Phillips deviates widely from his other figures, and approximates to this species, though it would appear to have had stronger concentric striæ.

Locality—Tyrone, *Benburb,* in shales.

SILURIAN—BRACHIOPODA.

Of the Brachiopoda none are geologically so important as those which are connected by their zoological relations with the ancient genus Anomia; and it was natural, therefore, that attention should be early drawn to the necessity of introducing such generic divisions as should facilitate the study and determination of the numerous species. "One of the earliest steps," remarks Professor Phillips, "on right principles of classification was made by the late Mr. Sowerby, in whose celebrated 'Mineral Conchology' the three natural groups of Terebratula, Spirifera, and Producta, were found fitting receptacles for a vast multitude of species previously ill distinguished. This simple view of the subject was found to throw great light on geological revolutions. Productæ range from some of the oldest strata to and into the magnesian limestone; Spiriferæ, commencing in as early periods, penetrate the lias; Terebratulæ, equally ancient, are also found through the secondary and tertiary periods, and yet exist."—(Pal. Fos., p. 52.) Mr. Sowerby created also the genera Magas and Pentamerus; and the principles on which the five genera were individually distinguished may be thus stated:—

TEREBRATULA.—Beak of the largest valve perforated; a pair of curved surfaces on each side the beak, and two shelly elongated appendages from the hinge.

MAGAS.—One valve, with an angular sinus along an incurved beak. A partial longitudinal septum with appendages attached to the hinge within.

SPIRIFER.—One valve, with a large angular sinus along the inside of the beak; two spirally coiled, linear appendages to the hinge nearly filling the shell.

PENTAMERUS.—Beaks imperforate. One valve divided by a longitudinal internal septum into two parts, the other by two septa into three parts or valves.

PRODUCTUS.—Beak imperforate; hinge transverse, linear; one valve convex, the other flat or concave externally. Some of these characters have been subsequently shown by Von Buch to be common to the subclass; but notwithstanding that objection, Mr. Sowerby's divisions, resting more on the greater development of such characters in some than in other genera, were simple and practical, and it is even doubtful whether the labours of subsequent writers have much improved them. Dalman (1827) proposed seven genera, distributed in two sections, of one of which Terebratula is the representative.

TEREBRATULA.—Beak of one valve perforated.

Leptæna.—Beak imperforate; hinge close, rectilinear, often exceeding the width of the shell; foramen none, or inconspicuous.

Orthis.—Hinge rectilinear and beaks distant; larger valve with a transverse smooth basal area and triangular foramen.

Cyrtia.—Hinge rectilinear; back of the larger valve elevated into a semi-cone or semi-pyramid, and the hinge side forming a vertical plane.

Delthyris.—Hinge more or less rounded; beaks distinct; both valves convex, the beak of the larger produced and provided with a deltoidal foramen.

Gypidia.—Larger valve with a produced beak, remote from the deeply inserted hinge; deltoidal foramen large; shell bilocular within.

Atrypa.—Hinge rounded, with beaks closely approximate; beak of the larger valve hiding the base of the lesser. Apex imperforate.

These divisions, like those of Sowerby, depend solely on the greater or less development of characters common to the whole sub-class, and in consequence the genera graduate so much one into the other, that it is sometimes impossible to decide on their limits, and the same species is in consequence shifted from one to the other. In this manner, for example, the passage from Leptæna to Orthis, is almost evanescent; and between Cyrtia and Delthyris there are so many intervening grades of form that some must necessarily remain uncertain.

Von Buch proposed an arrangement founded partly on the mode of attachment, and partly on the form and position of the foramen, and thus reduced the genera to three principal types which were again subdivided by minor characters.

Leptæna.—Neither valve perforated and no cardinal area; supposed by Von Buch to be attached by muscular fibres passing through tubes arranged along the hinge line, a mode of attachment which, if correct, would at once remove many of the supposed Leptænæ to the genus Orthis, as, for instance, Leptæna depressa, &c., and such is Von Buch's opinion, who describes them under the genus Orthis. Leptæna would, therefore, include only the normal species of the old genus Productus and the genus Strophonema.

Terebratula.—One valve perforated; the perforation separated from the hinge line by a deltidium. It includes Atrypa, Strigocephalus, Uncites, Pentamerus, Magas.

Delthyris.—One valve perforated; the perforation a triangular opening, the base of which rests on the hinge line, and the vertex reaches to the apex of the valve. It includes Spirifera, Orthis, and Cyrtia. In addition to the preceding, Calceola is distinguished from Leptæna by having a large cardinal area combined with imperforate valves.

In his original scheme of the Terebratulæ Von Buch placed Orthis in the Terebratula division; but in his subsequent work on the Delthyridæ, he rectified that arrangement, and brought Spirifer and Orthis together; his opinions in that respect being, therefore, in accordance with those of Professor Phillips.

Having reviewed the opinions of preceding writers, Professor Phillips advances an arrangement of his own, in which the Brachiopoda, exclusive of Lingula and Orbicula, are classed in three families, the variations in the foramen being adopted as the principle of separation.

Athyridæ.—Larger valve imperforate. No cardinal area—Producta. A cardinal area—Calceola.

Delthyridæ.—Larger valve perforated in or under the beak; perforation reaching to the hinge line. Cardinal area, more or less common to both valves—Orthis. Cardinal area confined to the larger valve. Internal plates of the larger valve separate—Spirifera. Internal plates of the larger valve united in the mesial line of the shell. Plates narrow—Strigocephalus. Plates very broad—Pentamerus. Cardinal area obsolete, beak incurved over a minute perforation, which is often obtect, or merely serves to receive the beak of the smaller valve—Cleiothyris.

Cyclothyridæ.—Perforation not reaching the hinge line. Beak truncate, perforate—Epithyris. Beak acute, the perforation below it—Hypothyris.

In this scheme of classification, Cleiothyris is proposed as a substitute for Atrypa, the opening in the beak not being absolutely deficient, but merely *concealed*; and Epithyris and Hypothyris as designations for the two sections into which the genus Terebratula may be divided. But, notwithstanding, he has thus suggested a new and comprehensive arrangement, no one is more sensible than Professor Phillips of the necessity of closely studying the whole order, and specially investigating the variations in the form of the internal appendages,—a necessity which was pointed out, at an early period, by Sowerby; and, in respect to which, Professor Phillips observes, that "it is often quite indispensable to know their form, before pronouncing on a fossil group." The investigation suggested would remove much of the obscurity which is still opposed to the natural arrangement of the Brachiopoda, and it would be rendered more perfect even for practical purposes. A satisfactory determination of the true limits of the genus Leptæna would be one of the results; but even now, when the genus is so far restricted as to be freed from those species which have an opening and cardinal area, however minute, it becomes the great characterizing fossil genus of the Carboniferous epoch, and its existence in the Silurian period is even doubtful. On this principle, I shall follow Von Buch, in considering many of the species usually classed with Leptæna, as belonging to Orthis.

ORTHIS *depressa.* LEPTÆNA *depressa*—(Dalman).

This species, though rare, is found in the Silurian schists. It will be noticed again in the Carboniferous strata.

ORTHIS *sericea.* LEPTÆNA *sericea*—(Mur.)—Pl. XXXII., figs. 23, 24.

"Semicircular; finely striated longitudinally, with a silky lustre; a few striæ deeper than the others; larger valve convex, the other nearly flat; front not concave, considerably deflected at the edge; length five lines; width ten lines." It is remarkable that this shell, which is one of the most abundant in our Silurian schists, exhibits precisely the same appearances as those noted in the above description, having, when the shell is preserved, a beautiful white silky lustre. Orthis sericea, Var. 2 (Mur.), in which the shell is more transverse, and narrowed in towards the angles, also occurs; and the various forms it assumes, according to the state of preservation of the shell, is shown in figs. 20, 21, 22; and a portion of the surface of fig. 23 is represented magnified. The species is small, the specimen represented fig. 24 being unusually large.

Locality—Tyrone, *Desertcreat,* in schists. The species is entered in Mr. Griffith's list, as occurring in the Carboniferous strata; but it has not hitherto come under my notice as a fossil of that epoch.

ORTHIS *corrugata*—(Portlock)—Plate XXXII., figs. 17, 18.

Orbicular; larger valve moderately convex, and, in large specimens, such as those figured, the ventral valve is also sometimes curved, but these appearances may, in part, as they are variable, be due to distortion in this delicate species; longitudinally radiated, as in O. sericea, with two sets of striæ, the strong occurring at intervals, and having finer striæ between them; transversely wrinkled or corrugated, as shown in the magnified views of figs. 17, 18, the wrinkles occurring in the spaces between the larger striæ, and not extending across the shell in definite or continuous rugæ. This is distinguished from Leptæna membranacea (Phillips) by the longitudinal striæ, and the partial character of its rugæ. It is usually smaller than the specimens figured.

Locality—Tyrone, *Desertcreat.*

ORTHIS *cancellata*—(Portlock)—Plate XXXII., fig. 19.

Orbicular, depressed; length ·75″, width 1·1″; finer adiating costæ, about twenty-five in number, with four or five smaller costæ between them; the whole being beautifully cancellated by numerous concentric striæ. Of this very beautiful species only the one valve found.

Locality—Tyrone, *Desertcreat.*

ORTHIS *hybrida*—(Murchison).

" Lenticular, most convex near the beaks, wider than long, radiated; radii increasing in number towards the margin; front rather straight; valves equal; hinge line short. Length five and a half lines, width six. Wenlock shale." The number of radii or fine costæ, increases by insertion of intermediate costæ towards the margin, but this is rather irregular; only one specimen of the larger valve found.

Locality—Tyrone, *Desertcreat.*

ORTHIS *testudinaria*—(Murchison). O. *testudinaria ?*—(Dalman).

The specimens with both valves are very small, about ·18″ long; orbicular; one valve very gibbous; the other convex at the sides, with a deep longitudinal impression in the centre; the radii, though delicate, are well defined costæ, and unequal in length, the shorter being interposed at the margin between the longer; they are granulated, though it is sometimes difficult to determine that character; the costæ are stronger than in O. canalis. Dalman states, in reference to his species, that it is very finely striated, large and small costæ alternating with each other; but, as he adds, that two or three of the smaller are interposed between each pair of the larger, it is probably not the same as the one described by Murchison, in which, as in our specimens, the radii are unequal in length, but not, in any marked degree, in thickness; larger specimen of flat valve ·3″ long.

Locality—Tyrone, *Desertcreat.*

ORTHIS *lunata ?*—(Murchison).

" Transversely obovate, approaching to orbicular, finely and deeply striated." There is only a cast corresponding to the form and striation of this shell; length ·45″, width ·65″.

ORTHIS *alternata*—(Murchison).

" Transversely obovate; finely radiated; one valve convex, the other flat or concave; radii extremely numerous, of unequal fineness, and increasing in number towards the edge; hinge line shorter than the width of the shell." Only one flat valve of a young individual obtained, ·27″ long, ·34″ wide; the hinge line being nearly as wide as the shell; radii very fine and thread-like; unequal in fineness, and more numerous at the margin.

Locality—Tyrone, *Desertcreat.*

ORTHIS *callactis*—(Dalman)—Var. β., Plate XXV. A, figs. 2, 3.

On the Graptolitic schists, there are two varieties of this shell; the one elongated, as in fig. 2; the other semicircular, as in fig. 3; only the flat valve can be distinguished; the folds agree with Dalman's Var. β., in which they are stated to be sharper, and to form distinct costæ rather than plaits.

Locality—Tyrone, *Desertcreat.*

ORTHIS *grandis*—(Murchison)—Plate XXXII., fig. 25.

"Semi-oval, short, nearly flat, irregularly radiate within; radii numerous, forked; length about one and a half inch, width nearly two inches." Mr. Sowerby adds that, "having only seen impressions of the interior of this fine shell, the description, as in many similar cases, is necessarily incomplete." The shell which I refer to this species, varies considerably in form, being sometimes longer than wide, and at others wider than long. The specimen figured is a small individual, and corresponds to Mr. Murchison's Plate 20, fig. 12; the radii are numerous, coarse, and either bifurcate, or have other radii interposed between them. In larger specimens, the radii at the margin are more irregular; the muscular impressions are well seen in the opposite casts, corresponding to fig. 13; they are not plicated as in O. expansa. Some of the specimens are 1·25″ long, and 1·65″ wide, and even larger; one valve is flat-convex, as represented in the section, though variably so.

Locality—Tyrone, *Desertcreat.* Sheet 37, Nos. 5, 6.

In respect to Orthis expansa, it is doubtful how far the furrows on the muscular impression, can be assumed as sufficient for specific distinction. They appear to be marks on what are casts of the impressions, and not the impressions themselves; and it is probable, that they occur in other species, as they do in the genus Leptæna.

ORTHIS *expansa*—(Mur.)—Var. concentrica, Plate XXXVII., fig. 1.

Semi-circular, flat, internally plaited near the margin; muscular impression deeply furrowed." The specimen which is thus described is an imperfect cast, and, from the figure and dimensions, was considerably more lengthened than a semi-circle. The specimens here associated with it are also deprived of the shell; they are marked by strong concentric lines of growth, deepest towards the margin, which is plaited, or rather is marked by the ends of the costæ. In the specimen figured, the peculiarity noted by Sowerby, in respect to the muscular impressions, can be traced, though it is far less strongly marked than in his figure; length 1·7″, width 1·9″. If this be really different from O. expansa, it may be called O. concentrica. The surface is not preserved, but appears to have been marked by fine thread-like costæ. A very large specimen is 2″ long, and 2·25″ wide. May not these be all modifications of O. anomala.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 6.

ORTHIS *pecten*—(Dalman).

Specimens of this rather uncertain species occur mixed up with the others; usually the flat valve. The hinge line rather exceeds the width of the shell, being angularly produced; the radii are fine, and by the frequent interposition of new costæ, they have the appearance of being arranged in sets of three and four. Species strongly resembling this occur in the Carboniferous strata, and Von Buch considers Spirifera arachnoidea (Phillips) as synonymous with it.

Locality—Tyrone, ***Desertcreat.***

ORTHIS *rugifera*—(Portlock)—Plate XXXVII., figs. 2 a, 2 b.

Semi-circular; hinge line slightly produced; radiated with very fine thread-like costæ, more numerous towards the margin; oblique rugæ between the beak and angle on each side; in a small specimen about four; one valve flat, the other unknown; length of small specimen ·37″, width about ·72″; not unlike Leptæna lata, but if there have been spines, they were extremely minute, and not like those of that species, which are rather strong, and long enough to be seen with ease; large specimens are longer in proportion; length 1·37″, breadth 1·65″.

Locality—Tyrone, ***Desertcreat.*** Sheet 37, No. 6.

ORTHIS *virgata*—(Murchison).

Described from an internal cast; has more radii than O. flabellulum; on the border of the cast, the impressions of the costæ are very strong, and appear as strong folds or costæ, with a small one between each pair. The exactly similar appearances and form in a single specimen leave little doubt of the identity of this species.

Locality—Tyrone, ***Desertcreat.***

ORTHIS *bilobata*—(Murchison).

"Transversely obovate, with a straight back covered by thin irregular radiating ridges; upper valve concave, with a broad angular elevation along the middle; lower valve very convex, with a deep broad channel along the middle; sides a little produced towards the extremities of the hinge line, rounded." A cast only of this shell ·56″ long and ·75″ wide; it is the upper, or large valve, with a very deep broad depression; the costæ appear to have been fine threads.

Locality—Tyrone, ***Pomeroy,*** in schistose grit.

In another specimen the form is the same, but the shell is less convex, and the depression much less deep; probably O. Vespertilio.—
Locality—Tyrone, ***Desertcreat.*** Sheet 37, No. 6.

ORTHIS *intercostata*—(Portlock)—Plate XXXVII., fig. 3.

The beaks not curved as in the ordinary form of Spirifer, though it is analogous to S. radiatus, and belongs to the sub-genus Cyrtia. A single specimen exhibits the following characters: nearly semi-circular; hinge area triangular, the height being equal to about a fourth of the width; no depression in the valve; marked by fine thread-like costæ or striæ, about sixteen of which have finer striæ between them; the striæ nearest the hinge are, however, all equal. On the cast the folds or ribs appear at the margin only, being there also alternately large and small.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 2 A.

LEPTÆNA *euglypha*—(Dalman).

One decorticated specimen has the form, but not the thread-like costæ, which are lost; in others, though not so deep as in Mr. Murchison's figure, the falling front is evident, and the fine radiating striæ, with stronger at intervals; the intervals between the stronger striæ are wider than in Orthis sericea; length ·75″, width 1·09″.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 2.

LEPTÆNA *duplicata*—(Murchison).

Described from internal casts. "Transverse, convex, internally marked, with furrows arranged in pairs; length five and a half lines, width nine lines." This very curious appearance on the cast is exactly represented by one of our specimens; and though its sufficiency for specific determination may be doubtful, it proves, at least, the probable identity of the Irish and English shells; width ·47″, length ·65″.

Locality—Tyrone, *Pomeroy.* Sheet 37, No. 50.

SPIRIFER *cyrtæna ?* DELTHYRIS *cyrtæna*—(Dalman).
Plate XXXVII., fig. 4.

The normal form is described as "sub-rhomboidal, finely radiated, gibbous at each side of the base, with the margin compressed and plicated; lesser valve elevated; greater with a sinus; beak prominent and incurved." Dalman observes that it greatly varies with age and locality, being sometimes furrowed or plicated throughout, at others only on the margin; sometimes having a very prominent and incurved beak; at others the beak short and close. The specimen here figured is plicated throughout; it is depressed, but the beak is prominent and incurved.

Locality—Tyrone, *Pomeroy,* in schistose grit.

Terebratula *lacunosa*—(Murchison)—Plate XXV. a, fig. 1.
Not Terebratula *lacunosa*—(Dalman).

"Obovate, gibbose, obscurely three-lobed, acutely plaited;" plaits about sixteen, four or five of which in the middle of the front are much elevated; beak small, pointed, slightly incurved; length 7 lines, width 8 lines. Terebratula crispata is described as rhomboidal, convex, transverse, subtrilobate, acutely plaited; plaits about eighteen, all terminating in the front; about six of them raised in the middle; sides smooth, beaks small; length 10 lines, width 11 lines. The principal difference between these species is the smooth sides of T. crispata. In form some of our specimens agree best with T. crispata, but all have more or less costæ on the sides. May not the two species pass into each other? Two varieties can at least be distinguished, the one having only six costæ on each side of the central elevation, which appears to be the normal species; the other having nine lateral costæ, and being somewhat more elongated, agrees with T. crispata in form, but has not the wide extent of smooth sides represented.

Locality—Var. 1, Tyrone, *Desertcreat*. Sheet 37, No. 6. Var. 2, Tyrone, *Desertcreat*. Sheet 37, Nos. 6, 2.

Atrypa *transversa*—(Portlock).

Description of the upper valve, of which one specimen only obtained; transversely elliptical, length 1·1″, width 1·75″; ends rounded; small elevated tongue in the middle, but generally nearly flat, or with a very slight convexity; concentric thread-like striæ, and lines of growth; similar in form to A. undata, but much less gibbous.

Locality—Tyrone, *Desertcreat*. Sheet 37, No. 6.

Uncites—(Defrance).

"Shell almost equilateral, but somewhat irregular, inequivalve, convex on both sides; the larger valve with a long incurved beak, which is scooped out from the beak to the hinge line, in order to receive the short beak of the smaller valve." Von Buch unites this genus to Gypidia, Pentamerus (Sowerby); but Bronn considers it distinct, not having been able to discover any hinge opening, nor any internal partitions; the irregularity of the shell seems also a reason for considering it generically distinct.

Uncites *gryphus*—Var. Plate XXV. a, fig. 8.

The specimens will not admit of making out more of the details of this curious shell, than that the beak is incurved and hollowed out.

It appears to be a smaller, more depressed, more elongated, and therefore narrower variety than that previously figured; the costæ are numerous, and separated by sulci nearly equal to them at the beak, but about twice their width towards the margin.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 2.

CARBONIFEROUS.

A few only of the species, which appear to require some further illustration, will be here noticed, the names and localities of the others being entered in the synoptical table. Several of these form a natural group with Orthis pecten—such as O. arachnoidea, O. crenistria, and O. umbraculum; and it is most probable, as suggested by Von Buch, that O. arachnoidea is only a variety of O. pecten, and O. crenistria of O. umbraculum. In respect to the differences between O. pecten and O. crenistria, one is removed by the remark of Dalman, that "in some specimens the longitudinal sulci appear, under a lens, to be transversely very finely striated," a term agreeing better with Professor Phillips' second description of O. crenistria—"the intervening spaces transversely striated"—than with his first. It should be kept in view, when considering this subject, how differently the same object appears under altered conditions; the impression of the flat valve of such finely striated species being readily mistaken for another species, as will be seen in our description. Von Buch points out a character sufficiently distinctive, were it always possible to appeal to it, namely, the difference in the cardinal area; in O. pecten it is so low as to be merely visible, both valves being very flat; but in O. umbraculum, though still low, it is considerably higher than in O. pecten, and is well marked in both valves. Unfortunately, however, the specimens will rarely admit of a verification of these differences; and when the outline and striation are alone relied upon, there is a great chance of error. Von Buch does not notice the transverse striation in O. umbraculum; but as he cites O. crenistria, in which that character is supposed essential, it may be assumed as, at least, compatible with his description.

ORTHIS *umbraculum*—(Von Buch)—Plate XXXVII., fig. 5.

Nearly semi-circular, and attaining to a considerable size; the specimens in the Fermanagh shales being 2·5″ long and 4·3″ wide; hinge line straight; ventral valve slightly convex towards the beak, but nearly flat at the margin; the cardinal area is low in proportion to the width of the shell, ·18″ high, and is strongly sulcated, the intervening ridges meeting at a very obtuse angle under the beak; the dorsal valve flat, and though crushed in all the specimens, has evidently had a low triangular cardinal area, the striation of which is not known from the specimens; surface finely threaded or costated, about twelve or fourteen costæ arriving at the beak, and others being inserted between them in succession, until, in a large specimen, the number at the margin amounts to two hundred, the dichotomy being by insertion, and not by furcation. In addition to the costæ, very fine longitudinal lines can be discovered by a lens; the spaces between the costæ are finely striated or wrinkled, a character, however, which is very variable in degree; when strongly marked, the fine longitudinal lines are quite obliterated; occasionally there is a thin coating of pearly shell, which nearly conceals the markings. The impression made by this shell is so different, and so peculiarly marked, that it may be readily mistaken for another species; the costæ become striæ, and the whole surface has then the appearance of the usual figures of O. pecten; the successively diminishing striæ forming sets of striæ between those which are more strongly marked; and the fine longitudinal lines, when they come out, strengthen the appearance of little aggregates, or bundles of striæ. It is a very curious and beautiful species.

Locality—Fermanagh, *Enniskillen*. Sheet 18, No. 7, in shale.

ORTHIS *analoga*—(Phillips). LEPTÆNA *analoga*—(Phillips).

A common species, judging from the identity of many of the specimens with Professor Phillips' figure and description in Pal. Foss.; it is, however, very doubtful that this is really a species distinct from O. depressa, or O. rugosa. Mr. Sowerby remarks that Leptæna depressa is easily distinguished from Producta analoga, the valves being almost equally convex in P. analoga, and the deflected portion descending very little lower than the convex surface of the lower valve; while in L. depressa, the middle of the lower valve is concave; the sides are expanded, like wings, at the extremity of the hinges, and the deflected margin is at least as deep as the valve is long. In Pal. Foss., the hinge line is stated to be extended to narrow ears; and the only ground for separation from L. depressa, is the irregularity of the sub-concentric wrinkles, and, in part, the usual concavity of the front. These characters seem very variable, the wrinkles being sometimes very regular, and, in young specimens, the front nearly round. Dalman's original characters were, in L. depressa, a rhomboidal disc, and *fine* concentric rugæ; in L. rugosa, a semi-circular disc, and *strong* concentric rugæ; and if they be considered sufficiently distinctive, L. analoga is more nearly related to L. depressa.

Locality—Tyrone, *Carnteel*.

ORTHIS *rugosa ?* LEPTÆNA *rugosa.*

One specimen only has occurred, which may be referred to this species; the outline is rounded, not rhomboidal, and the rugæ are very deep, strong, and much fewer, than in L. depressa.

Locality--Tyrone, *Derrylcran.*

ORTHIS *filiaria*—(Phillips). ORTHIS *Michelini.* TEREBRATULA *Michelini*—(Léveillé).

"Approximated to T. resupinata, but differs from it in never being spinous. It is finely striated; the number of striæ augment with the growth of the shell; upper valve convex, the lower almost flat; aperture for ligament imperceptible." There are two varieties of form,—the one shorter and wider, the other longer and narrower; the hinge line being very short, and the general form purse-like in both; the wide one is always strongly marked by transverse lines of growth, and agrees exactly with Léveillé's figure; some of the narrow variety are also occasionally so marked by lines of growth, but they are also frequently free from such markings, and then exactly correspond to Phillips' Spirifera filiaria. Léveillé mentions the curious impressions of the internal appendages, which are extremely well seen in some of the specimens; the short hinge line distinguishes this species from Orthis zonata.

Locality—Derry, *Slieve Gallion,* in shales; Tyrone, *Benburb,* and the red shale of *Kildress.*

ORTHIS *umbraculum*—Var. Plate XXV., figs. 12 a, 12 b.

Orbicular; length 1·1″, width 1·4″; the hinge line being rather less than the greatest width; strong radiating costæ, about sixteen, with finer costæ, three or four between them; only one valve noticed, which is very flat. The shell is here preserved, and however distinct it at first sight appears from that described p. 456, I have satisfied myself that when the shell is removed, both the appearances there noticed can be traced out. This species, therefore, and O. crenistria (Ph.), are only different conditions of the same shell; though, from the elevation of a portion of the costæ, it may possibly claim to be a variety.

Locality—Fermanagh, in shale.

ORTHIS *orbicularis*—(Murchison)—Var. Plate XXV., fig. 11.

This is a little wider in the hinge line, and a little more convex than the Silurian species, as figured; it has the aspect of a Leptæna; is orbicular, very convex, and finely radiated.

Locality—Fermanagh, *Enniskillen,* in shale.

ORTHIS *pulchra*—(Portlock)—Plate XXV., fig. 13.

A minute species, nearly semi-circular, finely radiated, and in the spaces between the *equal* costæ concentrically striated, or rather punctated: general form not known.

Locality—Fermanagh, *Enniskillen,* in shale.

SPIRIFERA *laxa*—(Portlock)—Plate XXXVII., fig. 6.

This is only a cast, but is so different from any of the figured species, that it becomes necessary to notice it: form transverse oblong; length ·87″, width 1·31″; mesial fold rounded, about four obtuse costæ on each side, dividing obscurely into two or three minor costæ; hinge area appears to have been low and triangular.

Locality—Fermanagh, *Magheraculmoney.* Sheet 6, No. 40, in ochreous grit.

SPIRIFERA *rotundata*—(Sowerby)—Var.

In Sowerby's description of this shell, with a very rounded outline, it is stated that the sinus of the dorsal valve is marked by obscure lines, the elevation of the ventral valve being quite smooth. In the present variety, the form is precisely the same, the shell being even more orbicular, and the flat lateral costæ are the same; but the elevation and sinus are both distinctly, though flatly, costated, the costæ being about four.

Locality—Donegal, *Bundoran,* in shale.

TEREBRATULA (ATRYPA).

In this division occurs the remarkable section for which Pander has proposed the name Porambonites, in which the ventral valve is the most highly developed, and the dorsal becomes the flattened or depressed valve. It embraces those shells which approximate in character to T. acuminata, T. platyloba, T. affinis, &c., of Sowerby, the two first of which have been supposed by Professor Phillips to be connected together by an almost imperceptible gradation of characters, the varieties being almost innumerable, and a specific character at present impossible." This difficulty will probably be, in part, removed, and some of the variations, now considered the results of age, hereafter prove specific differences. Two forms will be here noticed, as illustrating this position.

ATRYPA (Porambonites) *acuminata.* Var. *obsoleta*—(Portlock).

Length ·2″, width 2·1″; depth of both valves together 1·25″; dorsal valve flat; depression or sinus wide, shallow, and almost obsolete, producing an excavation or wave in the front of the ventral valve, but no distinct mesial rise or ridge; beaks very close; surface finely radiated, and towards the front numerous closely set lines of growth. A somewhat gibbous, clumsy-looking shell.

Locality—Boundary of Armagh and Tyrone. *Benburb.*

ATRYPA (Porambonites) *gibbera*—(Portlock)—Plate XXXVIII., fig. 1.

Length 1·16″, width 1·4″, depth 1·4″; the shell having therefore a remarkably elevated character when reversed or placed with the ventral valve upwards; both valves convex; the dorsal flat convex, for about one half its length, when it suddenly descends, and contracts in the centre to a small tongue, which protrudes into the ventral valve. In younger shells this would be less distinct, and in very young shells cease entirely; ventral valve very convex, like a hunchback, having a faint mesial rise corresponding to the tongue or sinus of the dorsal valve; beaks distant about ·16″; surface very finely radiated, appearing smooth to the eye.

Locality—Tyrone, in limestone.

PISCES.

In this extensive class, which, through the labours of Professor Agassiz, has acquired not merely geological importance, but a zoological interest of the highest order, it would be vain to attempt more than a brief notice of those species, which have either been observed in new localities, or have in themselves some peculiar geological value. At present no fishes have been discovered in our Silurian strata; nor in the old red sandstone any of the genera or species which have shed such a charm of novelty over that formation in Scotland and England; but in a portion of the Carboniferous strata the case is different, and the mountain limestone of Ireland has produced a rich and varied collection. The district which has hitherto proved the most prolific, is the limestone tract, which, ranging from Armagh towards Tynan, is in this respect strongly contrasted with other portions of the same formation. It has been perseveringly investigated by Captain Jones, M.P., whose large collection was submitted to Professor Agassiz on his late visit to this country. The Professor has named several new species, and has also established some new genera, and Captain Jones has kindly furnished me with the subjoined list. In addition to the fishes of the limestone, spines of the genus Gyracanthus, and large scales and teeth of a new species of Holoptychius, have been discovered in shaly strata, very analogous to those of Burdiehouse, rendered so interesting by the researches of Dr. Hibbert; they are figured in Plate XIII. The scales have a considerable geographical range, having been traced from the County of Derry, through Tyrone into Fermanagh, where they are accompanied by minute scales of Palæoniscus, and subsequently been observed by Mr. M'Adam, at Hollywood, in the County of Down; but the spines of Gyracanthus have hitherto been only found in the one locality, on the Moyola River, in the County of Derry. Of other formations, the new red sandstone of Roan Hill, near Dungannon, has produced the Palæoniscus Catopterus, and Triasic strata have been recognised in Aghanloo parish, by the scales of Gyrolepis, and the teeth of Saurichthys and Acrodus—Plate XIV. The greensand and the chalk have also contributed something to the list, though they yet require to be more rigorously examined. In passing the whole under review, the general list of the mountain limestone species, collected by Captain Jones, will be first given, and the descriptions of Professor Agassiz will be subsequently cited for those species which, in the course of these investigations, have acquired a more extensive geographical range.

LIST OF FISHES FROM THE MOUNTAIN LIMESTONE OF ARMAGH, CONTRIBUTED BY CAPTAIN JONES, M.P.

Psammodus.
1 P. *porosus.*
2 P. *rugosus.*
3 P. *cornutus.*

Helodus.
4 H. *turgidus.*
5 H. *dydimus.*
6 H. *lævissimus.*
7 H. *planus.*
8 H. *mamillaris.*

Chomatodus.
9 C. *truncatus.*
10 C. *cinctus.*
11 C. *linearis.*
12 C. ———

Cochliodus.
13 C. *contortus.*
14 C. *magnus.*
15 C. *oblongus.*
16 C. *acutus.*
17 C. *striatus.*

Cladodus.
18 C. *mirabilis.*
19 C. *acutus.*
20 C. *basalis.*
21 C. *striatus.*
22 C. *marginalis.*

Ctenoptychius.
23 C. *macrodus—dentatus* of Owen.
24 C. *serratus.*
28 C. *radicans.*
31 C. *marginalis.*

Petalodus.
25 P. *psittacinus.*
26 P. *lævissimus.*
27 P. *Hastingsii.*
29 P. *rectus.*
30 P. *sagittatus.*

Orodus.
32 O. *gibbus.*
33 O. *catenatus.*
34 O. *angustus.*

Ctenacanthus.
35 C. *arcuatus.*
36 C. *crenulatus.*
37 C. *heterogyrus.*

Asteroptychius.
38 A. *ornatus.*

Leptacanthus.
39 L. *priscus.*

Oracanthus.
40 O. *confluens.*
41 O. *minor.*

Ptysonemus.
42 P. *subteres.*

Onchus.
43 O. *plicatus.*
44 O. *falcatus.*
45 O. *rectus.*

Pæcilodus.
46 P. *obliquus.*
47 P. *parallelus.*
48 P. *Jonesii.*
49 P. *transversus.*
50 P, *sublævis.*

The following remarks of Captain Jones I am also permitted by him to append to his list:—"Since the preceding list was prepared several new fragments have been obtained, and Professor Agassiz has as yet only seen the drawings of them, made by M. Dinkel. I may say, however, that amongst these lately found remains, there are good specimens of one more tooth, somewhat allied to Psammodus, yet having a distinct character, which will connect it with the Myliobates, and several new dorsal rays.

"I have, since Professor Agassiz' visit to this country, continued to collect all the fish remains I could obtain from the quarries about Armagh, in order to satisfy my own mind on a point where I entertain some doubts. I think I am enabled to show that, however distinct and well marked the extremes may be, yet Helodus planus passes into Cochliodus magnus. I think, also, that Chomatodus truncatus does not belong to Chomatodus; we usually obtain the under surface of the tooth, but I have succeeded in partially clearing the upper surface, and I think the tooth belongs to Psammodus. I hope we may be able to retain the number of species named by the Professor; but it must be acknowledged that Cladodus basalis and C. striatus approach each other very closely; the same may be said of Petalodus serratus and P. lævissimus, and also of Pæcilodus transversus and P. Jonesii. Indeed, this last named species ought to be blotted out."—T. J.

AMBLYPTERUS AND PALÆONISCUS.

From the scales alone it is scarcely possible to separate these genera. Professor Agassiz was at first inclined to believe that the scales of Palæoniscus, of the Carboniferous epoch, were smooth, and those of the Zechstein striated; but subsequent research has shown him that this distinction does not hold good, and one mode of determining between the genera, in this geological period, is therefore lost. A single tolerably perfect specimen from the coal shales of Ballycastle, I was inclined to place in the genus Amblypterus: it has been submitted to Professor Agassiz, and as his determination of its true character has not yet been received, it will not be further noticed at present. In the clayey and marly bed of the Moyola, in Maghera parish, a fragment was found, in which several scales are combined together, and which strongly resembles the Ballycastle specimen; and a similar scale, of a rather larger size, in Fermanagh. This description of scale is figured Pl. XIV. A, fig. 14.

PALÆONISCUS *Robinsoni ?*—Plate XIV. A, figs. 13, 15.

The first of these scales is finely striated; the second quite smooth: it is possible that they belong to different parts of the same fish, as such differences have been noticed in P. Robinsoni. The sizes are also different, and the variation in proportion, from a nearly square form in the larger, to a lengthened rhomboidal form in the smaller, corresponds to that species. All these scales are detached and scattered.

Locality—Fermanagh, *Enniskillen.* Sheet 17, No. 4, in shale.

PALÆONISCUS *Egertoni ?*—Plate XIV., fig. 1.

This scale is strongly striated, and its posterior edge notched, or serrated.

Locality—Fermanagh, *Drumkeeran*. Sheet 5, No. 31, in shale.

Pl. XIV., figs. 3 a, 3 b, figs. 4 a, 4 b., fig. 5, are representations of what appear to be the scales which imbricate the front of the dorsal fins of the genus Palæoniscus.

Locality—Fermanagh.

Pl. XIV. A, fig. 16, represents a portion of the head of a fish, but the genus or species cannot be determined.

Locality—Fermanagh.

GYRACANTHUS *tuberculatus*—(Agassiz)—Plate XIII., figs. 14, 15.

This is one of those remarkable bodies, which were originally grouped together by Messrs. Buckland and De la Beche, under the common name "Ichthyodorulites." They are considered by them, and also by Professor Agassiz, as the bony rays of fins, similar to the spines of the dorsal fins of various cartilaginous fishes, such as the genus Spinax of our own coast, but principally belonging to genera which no longer exist. These rays are rounded in front, and marked on the sides by strong ridges, which meet in the middle of the front, at an angle of about 60°. In the present species, the lateral ridges are crenulated, or cut into sharp tubercles.

GYRACANTHUS *formosus*—(Agassiz).

In this species, the side ridges are only tubercular towards the lower margin of the ray, are undulated on the sides, and quite smooth in the middle. M. Agassiz thinks it possible that both species are really the spines of the same fish, the one being that of the anterior, and the other that of the posterior dorsal fin. Fragments of both kinds occur in the Maghera marly shale; and though the form of section differs a little from that given by M. Agassiz, they are probably the same species.

Locality—Derry, *Maghera*, in a marly shale, on the Moyola River.

HOLOPTYCHIUS.

Associated with the spines of the Gyracanthus are the teeth and scales, also figured in Plate XIII. These have a very strong resemblance to the scales and teeth of Burdiehouse, first made known by Dr. Hibbert, and named by Professor Agassiz H. Hibbertii. They have, however, been submitted to M. Agassiz, and by him are considered a distinct species. The large tooth, Pl. XIII., fig. 8, and the smaller, fig. 7, are more flattened and broader at the base than in H. Hibbertii, and the scales are remarkable for the radiated and cancellated structure seen in fig. 1 b, and also at the margin of the other scales. The small teeth, figs. 10 a, 10 b, 11, 12, cannot with certainty be ascribed to the same species, but, as in H. Hibbertii, the teeth are of two very different sizes: such may also be the case in this. Fig. 10 a has a finely furrowed base. Figs. 13 a, 13 b represent two views of what appears to be a portion of the jaw. Of the scales, which occur of the various sizes, and with the peculiarities represented, the anterior portion is irregularly granulated, and the posterior finely striated,—a character connected with the structure of the inner coat of the scale, as seen in fig. 1 a. The scale, fig. 6, is quite smooth and shining, and fig. 7 has probably belonged to the head. M. Agassiz has named the species H. Portlockii, and will describe it in his great work on fossil fishes. On the first discovery of the Burdiehouse fossils, the large scales and the teeth were placed in the genus Megalichthys; that name, however, has been since restricted to scales, such as that figured, Pl. XIV. A, fig. 12, which is a smooth, shining, enamelled scale—M. Hibbertii (Ag.) Holoptychius is a fish of the Sauroid type, approximating the class of fishes to that of reptiles.

Locality—Derry. *Maghera*, abundant; *Dungiven*, *Ballinascreen*, rare; Tyrone, Fermanagh, in shales, rare; Antrim, *Hollywood*, in marly shale.

MEGALICHTHYS *Hibbertii*—Plate XIV. A, fig. 12.

A smooth, shining, and rather thick scale, the only one met with. Some doubt exists as to the precise locality of this specimen, but I consider it Ballycastle: it is in shale, associated with fragments of plants.

TRISTYCHIUS *minor*—(Portlock)—Plate XIV., fig. 6.

In general form, the spines of Hybodus, Ptychacanthus, Leptacanthus, and Tristychius, have considerable resemblance, and they are all provided with a double row of teeth or prickles on their posterior face. Leptacanthus and Tristychius are the nearest allied to each other; but, according to Agassiz, the latter is distinguished from Leptacanthus by having strongly marked grooves on the surface of all that portion which is out of the flesh, and at the base fine striæ, which can also be traced in the grooves. It is further and more especially distinguished by three keels along its anterior face, one being medial, and the other two lateral. This genus was founded on a single specimen, from the shale of Greenside, near Glasgow; and some of its characters may be therefore considered doubtful as generic constants. The spine I here ascribe to it has three distinct grooves on its flattened sides, separated by rounded ridges or keels; and though it has been impracticable so to clear the spine, as to see the anterior face, a fragment of another keel is observable below the level of the sides, which may therefore have been part of the anterior keel. The portion which entered the flesh is finely striated; and, in another specimen, longitudinal striæ can be traced, with a magnifier, in the grooves. The posterior denticules are strong and slightly arched backwards; they diminish in size from the face to the point. The whole length is only 2·25″; it is slightly curved, and was probably sharp at the point. This is closely related to T. arcuatus (Ag.), though the posterior teeth do not appear to diminish from a central point towards both the base and the apex, as in that species.

Locality—Fermanagh, *Drumkeeran*, in shale.

PSAMMODUS—(Agassiz).

The teeth now to be noticed belong to the order of Placoids of Agassiz, or to the cartilaginous fishes of Linnæus, to the family of Squalidæ or sharks, and to the group of Cestraciontes, in which the teeth, fixed in the skin of the mouth, are arranged like a pavement. Of these, the genus Psammodus originally included all those teeth, whatever might be their form, the surface of which was neither plaited, striated, reticulated, nor surmounted by either longitudinal or transverse ridges or crests; it therefore comprised all those species which, possessing the ordinary structure of the teeth of Cestraciontes, namely, a crown formed of small tubes—see sections, Pl. XIV. A, figs. 1, 4—possessed the further peculiarity of a surface, more or less smooth, but granulated by the tubes of the crown. M. Agassiz has since greatly restricted it, by creating several new genera at its expense, and it now embraces a very small number of species.

PSAMMODUS *porosus*—(Agassiz)—Plate XIV. A, fig. 1.

Form oblong, rectangular, surface smooth, though very minutely granulated by the tubes. This is the ordinary form, but the tubes are sometimes so crowded together, as to produce corrugation on some portions of the surface, whilst the remainder continues smooth, thus exhibiting a passage to the next species P. rugosus, as is seen in Pl. XIV. A, fig. 2, which is from a very fine specimen, as was also fig. 1, in the collection of Captain Jones. Fig. 2 represents two teeth in their natural position, and a third had been also connected with them. Of these teeth generally, M. Agassiz observes, that so unlike is their appearance to that of ordinary fishes' teeth, that, at first sight, no one would take them for teeth; and that it required all the intermediate forms which connect them with the teeth of Acrodus, Ptychodus, and Cestracion, to convince him that they were really teeth of Placoids, and analogous to those of sharks.

Locality—Armagh; Tyrone, *Derryloran*; Derry, *Desertmartin*, in limestone.

PSAMMODUS *rugosus*—(Agassiz).

The superior surface is rugose, being sometimes covered with sinuous fringed wrinkles, and sometimes ornamented with a fine but irregular lace-work. Captain Jones is inclined to think that these two species pass into each other, and it is not impossible that they belong to the same species. The difference of form in different portions of the jaw is not at present known, and, as observed by M. Agassiz, many of the species must be considered merely provisional.

Locality—Armagh; Tyrone, *Carnteel.*

PSAMMODUS *cornutus*—(Agassiz)—Plate XIV. A, fig. 3.

Of this species Captain Jones observes—"Several specimens have been obtained where two teeth were in their natural position. The form is quite distinct from that of its congeners; it is trapezoidal, having a long and a short side, the long being more or less concave, the short more or less convex, and, when joined together, the convex side of the one tooth fitted into the concave side of the adjacent one."

Locality—Armagh; Fermanagh, in shale, associated with Tristychius minor.

COCHLIODUS *magnus*—(Agassiz)—Plate XIV. A, fig. 4.

The genus Cochliodus consists of those species of the original genus Psammodus which are more or less contorted, but have a smooth, enamelled, and porous crown. This species is gibbous, irregular, and only slightly oblique, or twisted; but it is almost impossible by words to give an idea of its form, which is subject also to much variation. The figure is from a fine specimen belonging to Captain Jones.

Locality—Armagh; Tyrone, *Desertcreat*, in similar reddish limestone.

In the genus three other species have been established—C. *contortus*, (Psammodus *contortus*, Agassiz); C. *oblongus*, Pl. XIV. A, fig. 5, fig. 10; C. *acutus*. The two last were discoveries of Captain Jones; and on the first, he had the good fortune to throw a most unexpected light, by a specimen in which the teeth, which had been before considered single and detached, were found to be united in a pair, constituting, as it were, the frontal portion of a bony palate. May not this be the case also with C. oblongus? C. *acutus*, as is suggested by Captain Jones, may belong to a different portion of the jaw of C. *contortus*, C. *acutus* filling up the space between the frontal or double tooth.

Locality—Armagh; also of C. *acutus*, Tyrone, *Errigal Keerogue*, in limestone; and Fermanagh.

CHOMATODUS *linearis*—(Agassiz)—Plate XIV., fig. 8.

Chomatodus includes those teeth of the original Psammodus which have the base of their crown surrounded by concentric folds, more or less distinct, and more or less numerous. The present species is in adult specimens long and narrow, and the cinctures are few and close together. The crown is very smooth, and at the cinctured edge slightly wrinkled.

Locality—Armagh; Fermanagh.

CHOMATODUS *cinctus*—(Agassiz)—Plate XIV. A, fig. 9.

A fine specimen from Captain Jones' collection is figured to show the difference of form, &c., as compared to C. linearis.

Locality—Armagh, in limestone.

ORODUS *ramosus*—(Agassiz)—Plate XIV. A, fig. 8.

The genus Orodus possesses lengthened teeth. in which the medial portion is more elevated than the extremities, and forms in the centre of the tooth an obtuse and transverse cone; the longitudinal diameter, which is by far the most considerable, is also raised into a crest (which is sometimes medial, sometimes sub-medial), from which proceed oblique wrinkles, which in the larger teeth are ramified at the edges, and even have collateral wrinkles. The Orodi represent in the older strata the Acrodi of the Triasic, Oolitic, and Cretaceous formations.

The chief differences between the two species first described by Agassiz, O. cinctus and O. ramosus, may be thus stated: in O. cinctus there is *not* a marked longitudinal crest or ridge, and the lateral folds are simple and divided by deeper hollows; in O. ramosus there is a distinct longitudinal ridge, and the lateral folds or wrinkles branch or separate into lesser folds towards the margin. The present specimen seems intermediate in character, the longitudinal ridge being tolerably marked, but the lateral plaits few and simple. M. Agassiz, in fact, remarks that he separates these teeth into two, as he had not discovered any connecting gradations of form: his figures, however, show that the smaller teeth possess the characters of O. cinctus, the larger of O. ramosus, and it may not therefore be impossible that the character of the tooth varies with age.

Locality—Wexford, *the Hook*. Contributed by Captain James.

CTENOPTYCHIUS *macrodus*—(Agassiz)—Plate XIV., fig. 7.
PETALODUS *dentatus*—(Owen).

The teeth of this genus M. Agassiz considers allied to those of Orodus, but distinguished by their compressed or flattened form, and by their pectinated crest. The name Petalodus has been applied by Professor Owen to the same teeth, but it is admitted by Agassiz for those only in which the pectinated character becomes obsolete. In this species the crest is denticulated, the denticules being tolerably large and blunt. It differs from C. apicalis (Agassiz) by the form of the crest, which is rounded and not tending to a point as in that species. The specimen is a young individual.

Locality—Armagh; Tyrone, *Carnteel*, in limestone.

PETALODUS *rectus*—(Agassiz)—Plate XIV., figs. 9 a, 9 b.

Distinguished by the depressed and straight crown, which loses entirely the thin scale or petal-like character.

Locality—Armagh, in limestone; Bundoran, in shale.

PETALODUS *Hastingsii*—(Agassiz)—Plate XIV., fig 10.

The crest is here finely striated, the striation not amounting to pectination, though slightly affecting the edge. The specimen is unusually large.

Locality—Armagh; Tyrone, *Clogher*, Sheet 64, No. 46, in dark limestone.

PÆCILODUS *Jonesii*—(Agassiz)—Plate XIV. A, fig. 6.

Pæcilodus is a new genus, established on the specimens of Captain Jones; it is remarkable for the folds or plaits on a portion of its surface, the general form approaching to that of Cochliodus. This, as well as the next species, are figured for comparison with the specimen represented in fig. 11.

Locality—Armagh, in limestone.

PÆCILODUS *transversus*—(Agassiz)—Plate XIV. A, fig. 7.

The folds are continued more across the tooth, are less twisted, and not so strong.

Locality—Armagh, in limestone. Contributed by Captain Jones.

PÆCILODUS? CEPHALASPIS?—(Portlock)—Plate XIV. A, fig. 11.

This small fossil is obscure, and is here placed with doubt. The lower figure represents it of the natural size, and the upper magnified. It appears, when perfect, to have run out to a point, or nearly so; the folds are very delicate, occasionally duplex or irregular, and at their edges finely striated. This is the only specimen, and has a shelly or scaly appearance.

Locality—Derry; *Ballynascreen*, in the shales of the White Water.

POIKILITIC.

PALÆONISCUS *catopterus*—(Agassiz).

This curious fish has been submitted to Professor Agassiz, and will very soon be published by him in the "Fossil Fishes." It appears to have been in great abundance in one locality, and in one layer of the red earthy sandstone of Rhone Hill, near Dungannon. The space occupied by the fishes was very small, being not more than a few square feet, and the specimens obtained entirely exhausted it; for though an excavation was made of considerable extent, and carried carefully down to the level of the layer, and then below it, not a single additional specimen was discovered. Within that space they were crowded together, the surface of the layer being covered with them. The general size is 2·9″ long, but one which is more isolated is 3·75″ long and ·63″ deep. A small shell, Posidonia minuta, which, though not actually in the same layer, is found in the soft clayey seams which separate the adjacent layers, has been found in other localities, but without any trace of the Palæoniscus. The only known locality is therefore Tyrone, *Rhone Hill.*

TRIAS (MUSCHELKALK ?)

I have noted this geological reference with a mark of doubt, which has been also applied to it by the Earl of Enniskillen and Sir Philip Grey Egerton in their catalogue. The number of supposed characteristic species is, however, a good reason for removing the strata containing them from the Lias to the upper division of the New Red; and this is therefore another probable example of strata of the Muschelkalk epoch in the British islands.

GYROLEPIS *Albertii*—(Agassiz)—Plate XIV., figs. 12, 13, 14.

The striation of these scales, which is better shown by the figures than could be explained by words, is apparently stronger than in those of the next species; and as Professor Agassiz decided that some of the scales belonged to this species, I think it cannot be wrong so to refer them.

Locality—Of this, and the following species, see Chap. IV., page 107.

GYROLEPIS *tenui-striatus*—(Ag.)—Plate XIV., figs. 11 a, 11 b, 11 c.

The striation is more delicate and regular. Several views of the scales have been given to show their appearance on both sides, and figs. 15, 16 are of scales in which the structure is seen to be by successive layers, but whether they are actually the same or not cannot be determined. Fig. 12 a, illustrates the manner in which they occur scattered on the face of the slab.

ACRODUS *minimus*—(Agassiz)—Plate XIV., figs. 18 a, 18 b.

In the Acrodi the crown of the tooth is swollen in the middle, rounded on the sides, and narrowed at the two ends; the enamelled portion of the surface is adorned with transverse wrinkles or plaits. The form of this minute tooth will be readily understood by reference to the figure: it possesses a distinct longitudinal ridge. Figs. 17 a, 17 b, represent another form in which the sides are more lengthened, and slightly arched. This, I am informed, Professor Agassiz has formed into another species, but I have not as yet learnt the name.

SAURICHTHYS *apicalis*—(Agassiz)—Plate XIV., figs. 19 a, 19 b.

A conical tooth of a Sauroid fish, with a striated, or rather minutely furrowed base, a character which is shown by the magnified view, fig. 19 b.

COPROLITE. Plate XIV., fig. 20.

It appears to have been a Coprolite, probably also of a Sauroid fish, and is studded with fragments of the preceding species.

CRETACEOUS.

M. Agassiz distinguishes the teeth of Oxyrhina from those of Lamna by the absence of the small denticules at its base; when the base is imperfect, it is therefore difficult to decide on the genera. Such is the case with our specimens, one of which strongly resembles Lamna elegans (Ag.), and the other, which is shorter and broader, is exceedingly like the species figured by Geinitz as an Oxyrhina, but to which he does not give a specific name; they are both from the greensand. From the greenish chalk conglomerate of Tamlaght, small triangular teeth, with serrated edges, have been obtained, which probably belong to the genus Hemipristis (Ag.), but are not sufficiently perfect for specific identification. There cannot be a doubt that the future minute examination of the Cretaceous strata in Antrim will add considerably to this list.

ADDENDA—SILURIAN.

Plate XXIV., fig. 10.

Respecting the true nature of this body, I cannot fully satisfy myself; the semi-oval form of the inner portion, and the somewhat irregular lines upon its surface, resemble what might be expected from the internal cast of a Cypris; but it has an external rim, with an obscure appearance of angular parts. Can it be the internal cast of the cephalothorax of a Trilobite, allied to Remopleurides? The lines are slightly irregular, waved, and converge to the axal line; they are, probably, membranaceous markings.

Locality—Tyrone, *Desertcreat.* Sheet 37, No. 2 A.

CEPHALOPODA ?—Plate XXIX. A, figs. 6, 7 a, 7 b.

The exact nature of these bodies cannot be determined; they are elongated triangular impressions, no part of the original substance remaining. Fig. 6 is smooth, rounded at the broad end, and suggested the idea of the internal bone of a minute Cephalopode; but the cancellated structure of fig. 7, though very fine, renders the supposition doubtful, and even makes it possible that it is a minute Flustra.

Locality—Tyrone, *Desertcreat.*

ORTHOCERAS ?—Plate XXIX. A, fig. 1.

Elongated, very minutely annulated; in form it is indistinct, and therefore there is some doubt as to the genus; its resemblance to a portion of Conularia elongata, fig. 2, is considerable, but it is probably round, and if so an Orthoceras.

Locality—Tyrone, *Desertcreat.*

BELLEROPHON *alatus*—(Portlock)—Plate XXXIII., fig. 9.

Back sharply angular; aperture expanded, with flattened, wing-like sides, triangular from the angularity of the back, and without a sinus; spire suddenly involute, not umbilicated. The striæ proceeding from the wings to the back are curved, and the wings have also a twisted appearance, and are not quite symmetrical. This very remarkable shell, looked at in the way it is figured, was difficult of determination, and I was at first inclined to consider it a bivalve, allied to the genus Isocardium, and have so spoken of it; but a broken specimen has since shown me that it is really an involute univalve shell. It is allied to B. expansus (Mur.), though distinguished from it by its keeled or angular back, and the want of a sinus. B. expansus is from the Upper Ludlow.

Locality—Tyrone, *Desertcreat.*

CARBONIFEROUS.

BELLEROPHON *Oldhami*—(Portlock)—Plate XXXV., fig. 4.

Sides compressed, back keeled or sharply angular, aperture triangular, spire involute, umbilicated. Fine longitudinal or spiral striæ and transverse striæ, which on approaching the back are slightly retroflexed, and crenulate the keel. In the form of aperture and in the transverse striæ, which also crenulate the keel, B. Duchastellii, of Léveillé, seems identical with this species, but it is represented as wanting spiral striæ: in form also, B. carinatus (Murchison), a fossil of the old red sandstone, approximates to it, the aperture being an equilateral triangle, but it is stated to be smooth. I dedicate this species to my zealous and able assistant, Mr. Thomas Oldham.

Locality—Tyrone, *Clogher.* Sheet 64, No. 27.

BELLEROPHON *spiralis*—(Ph.)—Var. Pl. XXXV., figs. 6 a, 6 b, 6 c, 6 d.

Described by Phillips as "ovate, umbilicate, edges of the umbilicus and back obtuse-angled; many spiral furrows and ridges, surface very minutely granular (cast smooth)." In this variety the furrows and ridges are not numerous, and are strongly marked. In the cast the back is rounded, but when the surface is preserved it is keeled or ridged; no traces of the minute granules; cast smooth. In fig. 6 a, of the natural size, a portion of the cast is seen, and is smooth, and a portion of the ridged surface; this is magnified in fig. 6 b. Figs. 6 c, 6 d, represent the shell, looking at the sharp edge of the surface, or the smooth rounded outline of the cast.

Locality—Tyrone, *Derryloran* (Cookstown). Sheet 29, No. 1.

BELLEROPHON *recti-costatus*—(Portlock)—Plate XXXV., figs. 5 a, 5 b.

Cast widely umbilicated, back and sides obscurely ridged, aperture about three times as wide as high; shell, of which a small portion only remains, is ·1″ thick; has a band ·12″ wide, which is marked with strong transverse, arched striæ, from the ends of which proceed strong, straight (not curved as in B. *hiulcus*, B. *costatus*,) striæ over the sides. The striæ correspond nearly with those of B. costatus in strength, but by being straight and nearly perpendicular to the band, approximate to those of B. tangentialis (Phillips), from which species, however, this is distinguished by the form of aperture. In respect to other species, the cast has some similarity to B. apertus (Sowerby), originally described from a cast; but if the specimen of that species figured by Phillips be correctly identified, this is distinct from it; it is also wider in proportion to its length than in Sowerby's figure, or in other casts which seem to be clearly referrible to B. *apertus*. The difficulty of recognising species described solely from casts must necessarily be great, and it is not improbable that two species are confounded together as B. cornu arietis, just as two may have been so confounded in B. apertus: one of these appears to be more elongated and less wide than the other.

Locality—Armagh, in reddish limestone.

ORTHOCERAS *latissimum*—Plate XXXV., figs. 2 a, 2 b.

For description see page 390. Fig. 2 b represents an external view of the shell, and fig. 2 a a polished section, in which the lateral siphuncle may be obscurely traced.

ORTHOCERAS *maximum*—(Münster)—Plate XXXV., fig. 3.

For description, see page 388. This represents a polished section, showing the peculiar structure of the siphuncle noticed by Münster. It is from a much smaller individual, but in this respect it seems impossible to draw the line of specific distinction, and it cannot be doubted that different names have been given to the same species, when seen in different stages of growth.

POSIDONOMYA *complanata*—(Portlock)—Plate XXXIV., fig. 12.

Very minute, having, at first sight, much of the aspect of a Cypris; transverse, the beaks nearly obsolete, and close to one end; inequivalve, one valve slightly convex, though much depressed; the other quite flat, and, as it were, set into the larger like a Pandora; hinge line nearly straight, surface marked by fine concentric lines of growth. The magnified figure gives the form and character of the shell, which is naturally not more than ·12″ in transverse length, the height being rather more than one third of the length; at first sight this recalls P. minuta (Bronn), but the inequality of the valves, the position of the beaks, and the delicacy of the striæ distinguish it.

Locality—Derry, *Ballynascreen*. Sheet 41. White Water River, in shales, at the very base of the Carboniferous system, or rather in strata, which appear to exhibit a transition from the Carboniferous to the old red sandstone.

HOLOPTYCHIUS ?————Plate XIV., figs. 2 a, 2 b.

This scale has some resemblance to that figured by Phillips (Pal. Foss., Pl. 57, No. 257). It is elongated, irregularly oval, and marked by strong striæ, or rather fine sulci, parallel to the border; it is smooth and shining. The genus is doubtful.

Locality, Fermanagh, in shale.

HELODUS *turgidus*—(Ag.)

Locality—Donegal, *Templecarn*.

Of the class of Mammalia, research has hitherto discovered very few relics within this district. The great deer of Ireland, Cervus megaceros, has been found near Armagh, but not, to my knowledge, in Derry. Antlers of the red deer, Cervus Elaphas, of a large size, have been found occasionally in the bogs, and also, in one instance, buried deeply in a crevice of the chalk of Balteagh parish. In the latter case the antler has undergone considerable change, and become white, loose, and porous. In form there is considerable difference between the several specimens, and I am not as yet satisfied that a second species does not exist amongst them, but I must reserve the consideration of the question for the present. The horn of the small horned cattle has also been found in the bogs. Of larger animals a single tusk of a hippopotamus, found in the gravel near Carrickfergus, is the only example: it was contributed by Mr. David Moore, when botanist to the Geological Department.

Time has forced me to curtail and close this list, though there are yet numerous objects from the Carboniferous to the Cretaceous strata, which require to be figured and described. In the synoptical table those will be entered which are easy of identification, but the others must be reserved for a future opportunity: enough have, however, been here noticed to assist in the description and separation of the strata within this district, though the Carboniferous strata, as a whole, can only be satisfactorily determined by the extended examination and comparison of the fossils of the whole system, and specially of those great natural sections, which are afforded by the strata of Leitrim, Fermanagh, and Sligo. When this is done, and it was the great object I had in view, it will be easy to allocate the detached members of Derry and Tyrone to their proper places in the more defined sections of the other counties. The comparison with the Silurian strata can be effected with more ease, as for that purpose the data may be considered tolerably complete.

In estimating the practical bearing of the Silurian fossils which have been here described, the appended tabular summary enables us to state 1. The remarkable distinctness of the line of zoological demarcation between the Silurian and overlying formations in Ireland. 2. The greater amount of species common to Foreign and Irish, than to British and Irish strata. 3. The great number of species as yet only noticed in the Irish strata.

That these results may, in part, be due to the great difficulty of identifying fossils is true, but making every allowance for that difficulty, the comparative view could not be materially altered; nor are the results inconsistent with reason, as it should be expected to find in the ancient Fauna local peculiarities similar to those noticed in the recent. The great mass of the Irish Silurian strata is composed of schists, the dividing limestones being deficient, and it is therefore more analogous to the foreign than British deposits; but even independent of this natural cause, every locality may be expected to produce species, which for a time seem peculiar to itself, just as the Pomeroy schists contain the Ampyx Sarsii, and the Tramore schists the A. Austinii; and if the fossils of the various quarries of even a limited space of country were individually compared together, this description of difference would appear still more striking, as it is probable that almost every one would produce its own peculiar novelties, according as the absence or presence of particular beds tended to modify the results. Of these effects it will be necessary to speak more at large in the description of the Carboniferous strata. In the present case, the fossils common to the Irish and British strata are highly characteristic of the formation, and in some instances, as, for example, in the genera Trinucleus and Phacops of the Crustacea, extremely abundant and well preserved; and in like manner the greater proportion of those common to Irish and Foreign strata are equally characteristic of the most ancient fossiliferous strata, whilst in the district itself the isolated zoological character of the formation seems even more strongly marked than in Great Britain; and it becomes therefore a still safer basis of comparison. If proceeding from individual species the comparison be made by groups, the results are still more striking: compare, for example, our Plate I. B, with Mr. Murchison's Plate XXIII. or Plate XIX., with his Plate XXVI., and the conviction is at once realized that they represent co-existing Faunæ. The particular position of the larger portion of the strata in the Silurian formation seems also by the same comparison to be low down, and I have therefore considered two-thirds at least to belong to the Llandeilo flags and Caradoc sandstones, but, in ascending, the upper portion is found to have acquired a decided grit-like character, and to vary in the proportion of its fossils; Trilobites are very rare and reduced to fragments, such as a portion of the cephalothorax of Trinucleus, but Leptæna sericea still continues and is associated with a costated Spirifer, S. cyrtæna, and a group is therefore formed of a very different aspect to that of the lower schists; here, then, is probably a higher member of the formation, Plate G, fig. 2; though, as yet, a transition by fossils, through the Devonian system to the Carboniferous, has not been here ascertained. Enough has been now said to prove, that a true Silurian deposit, of a considerable vertical thickness, but of small lateral extent, unless a portion of the adjacent grits belongs to it, exists in the County of Tyrone and again appears in Fermanagh:* a few also of the Waterford fossils, contributed by Major Austin and Captain James, have been described, and they are equally conclusive as to the existence of a Silurian formation there, which, however, has yet to be minutely examined and illustrated. Strata, in Kerry, supposed similar, require also to be closely studied; and, finally, Mr. Griffith has discovered Graptolitic beds in the County of Meath, near Slane.† These are, probably, only scattered remnants of a formation once spread over larger spaces, but like the mica schist below, and the old red sandstone above, worn away by the destroying agencies of nature: and if so, they supply in their isolated condition stronger proofs of successive epochs of disturbance and of rest, of destruction and of formation, than are even found in the varying aspects of successive Faunæ.

In the Section Plate G, fig. 2, the following variations in the strata have been noticed. At the base they are quartzose, and near their junction with the sienitic rocks massive; in one instance appearing to have become a hard, slightly calcareous quartz rock. The principal mass is schistose, or flaggy, becoming near the base at Bardahessiagh gritty, and the large Orthis is there most abundant. In one locality the slates are even and smooth, and particularly rich in Graptolites,—coinciding nearly in direction to the Graptolitic bed, and, probably, succeeding it in order, the strata vary locally in character, as is seen in the river bank; they are more massive and calcareous, and at one place contain an abundance of Pyrites. In the great schistose mass carbonate of lime is rare, though it can be occasionally traced in some of the smoother varieties; thin beds of grit are also rare, but towards the termination of the section, in an ascending order, the schists are succeeded by a distinct schistose grit, which approximates in character to some of the overlying grits, and the characteristic fossils become scarce, and detached in fragments.

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*Fragments of Trilobites, too imperfect for satisfactory description, occur in the Lisbellaw schists; they are not, however, carboniferous.

† Nov. 5, 1842. Mr. Griffith informs me by letter that he has just discovered another small silurian district, connected with red sandstone, in the County of Mayo; that it differs from the preceding, the slates alternating with impure calcareous beds, which are filled with upper silurian fossils, but as yet no Trilobites have been found in them.

SUMMARY OF THE SILURIAN FOSSILS DESCRIBED IN THIS CHAPTER.

CLASSES AND ORDERS.	Noticed in the Irish Strata alone.	Noticed in British and Irish.	Noticed in Foreign and Irish.	TOTAL.	Geological position of British species.				Common to Irish Silurian and Carboniferous.
					Carboniferous.	Devonian.	Upper Silurian.	Lower Silurian.	
POLYPARIA, . .	7	9	5	21	–	1 · 1*	5 · 1*	3	2†
CRINOIDEA, . .	1	1	–	2	–	–	–	1	–
CONCHIFERA,									
Order Dimyaria, .	16	2	1	19	1	–	–	1	–
Order Monomyaria,	2	1	2	5	–	–	–	1	–
Order Brachiopoda,	9	15	3	27	–	–	3 · 2*	12	1‡
MOLLUSCA,									
Order Gasteropoda,	10	1	5	16		–	1	–	–
Order Cephalopoda,	20	6	10	36	1*	2	4	–	1
Order Heteropoda,	3	2	–	5	–	–	1	1	–
Doubtful, . .	1	–	–	1					
ANNELIDA, . .	4	–	–	4	–	–	–	–	–
CRUSTACEA, . .	32	7	13	52	–	–	3	4	
	105	44	39	188	1 · 1*	3 · 1*	17 · 3*	23	

The * signifies that the species again occurs in the successive columns.

† Catenipora escharoides occurs in Portrane limestone, associated with carboniferous Crinoids; the true position of this limestone has not as yet been satisfactorily determined.

‡ This is on the supposition that O. depressa is not sufficiently distinguished as a species from O. analoga.

CHAPTER X.

OLD RED SANDSTONE, AND NEW RED SANDSTONE.

If it be found occasionally difficult to draw a line of demarcation between successive geological formations, even where members of strongly contrasted mineralogical characters, such as limestones, clays, sandstones, are present in sufficient quantity, and sufficiently isolated from each other to afford some tangible marks of separation, how much more obscure and difficult must be the search for lines of geological division in a long series of sandstones, diversified only by marls, shales, and impure limestones, which are not isolated into distinct and prominent groups, but are mixed up with, and subordinate to, the sandstones. This is no new difficulty: Professor Sedgwick and Mr. Murchison remark on a similar case in Devonshire (Trans. Geol. Soc., vol. v., p. 694). "This is a measure of necessary caution, especially when we bear in mind the extreme difficulty, in the northern part of our island, of drawing any precise line of demarcation between the base of the coal measures and the old red sandstone;" and again, "The difficulty we have pointed out, does not arise from any doubt respecting a great principle of classification, but merely involves the adjustment of a boundary line. One of the best illustrations of this difficulty is seen on the east coast of Scotland, north of St. Abb's Head. The old red sandstone first appears as a conglomerate, resting transversely on the edges of the graywacke; and then passes so insensibly into the red carboniferous rocks, that through a considerable extent of coast it is hardly possible to draw any well defined line between the two formations. We may, however, observe by the way, that there are several pretty extensive tracts coloured as old red sandstone in Macculloch's Geological Map of Scotland, which we believe every geologist who was guided by the English types would class with the lower division of the mountain limestone; and there are one or two places in Dumfriesshire, where we think he has confounded the new with the old red sandstone." These remarks so peculiarly applicable to the sandstones of the County of Derry will explain why the whole of them (see Chapter II.) were at first placed in the new red sandstone, and why the greater portion were subsequently transferred to the yellow sandstone, or transition member between the old red sandstone and mountain limestone. But the difficulty of deciding will be rendered even more apparent by following the succession of strata—first downwards, from what may be presumed the new red sandstone—and then upwards, from what may be considered the old red sandstone. Prior to the present investigation no fossils had been found, or even sought for, in the sandstones of Derry;* hence it is evident that any separation of the strata, extending from the old to the new red sandstone, could only have been effected by reference to variations in mineral structure, or to want of conformability of stratification. Where, therefore, no marked unconformability could be traced, and where there was a complete gradation of mineral type from top to bottom, such separation must have been, in a great measure, arbitrary. In the parishes of Maghera, Kilcronaghan, Ballynascreen, and Desertmartin, as also in the County of Tyrone, the presence and position of the mountain limestone were sufficient to show that all the sandstones could not there belong to the new red sandstone; but the total absence of any well marked portion of the mountain limestone in the north of Derry, involved that district in the obscurity which has been noticed. Before proceeding further, it may be observed that Mr. Griffith has entirely excluded the old red sandstone from the County of Derry, and substituted for it "the yellow sandstone," a geological division which requires to be more fully defined and understood.

To the propriety of continuing such designations, as green, yellow, and red, for geological formations, some objections have already been urged; and they are peculiarly applicable in this case, as those sandstones, which are sometimes yellow on the weathered surfaces, are white internally: for example, those of Dungiven, and many of those of Ballynascreen, and of various parts of Tyrone and Fermanagh, whilst a very large proportion of the "yellow sandstone" is decidedly red; but the inquiry may also be made, whether the "yellow sandstone" formation has as yet been sufficiently defined to be admitted as a distinct geological division, and whether, in practice, it always occupies the same position. In the great geological map of

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* I should except Altmover Glen, the fossil plants of which had been observed by Captain Jones.

Ireland, Mr. Griffith places the "yellow sandstone" at the base of, but in the carboniferous system; and in his "Outline of the Geology of Ireland," which accompanies the Railway Commissioners' Report, he characterizes it as alternating at its summit with the mountain limestone, and having been hitherto considered part of the old red sandstone. Hence it is evident that the "yellow sandstone" so defined, should be a transition formation between the old red and the carboniferous systems. Something more, however, is necessary; namely, to define what is meant by alternation, for if the term be allowed an unlimited extension, the yellow sandstone might extend over, and absorb within it, portions of the true carboniferous system. The term alternation can only then apply in cases where, at the junction of two formations, beds of each are associated together in nearly equal proportion, so as to form a passage from one to the other; the transition system thus constituted being placed either at the top of the lower, or at the base of the higher of the two systems, according to the relative importance of the alternating strata; and hence if the sandstones and shales of the yellow sandstone do alternate with decided beds of the mountain limestone, the yellow sandstone is rightly placed as the lower member of the carboniferous system. Beyond these limits the principle of alternation cannot go; if, therefore, a well marked member of the overlying portion, such as the mountain limestone, be recognised and admitted as such, alternation ceases, and any sandstones or shales found above it can no longer, however similar in character, be considered the same, geologically, as those below it. My impression is that the yellow sandstone at present occupies, in some parts of the geological map of Ireland, this double position, partaking at once of the character of a geological and mineralogical designation—geological when below, and alternating with subordinate beds of the lower portion of the carboniferous system—mineralogical when occurring above extensive and recognised members of that system: for example, geological where it occurs between the old red sandstone and the base of the carboniferous system, as a very striking transition member between the two on the boundary of the counties of Donegal and Fermanagh—mineralogical where it occurs above a recognised portion of the lower mountain limestone in the north of Fermanagh, in the islands along the northern shore of Lough Erne, and, even more strikingly, on the west of Lough Erne, in the Derrygonnelly and Monea district, and also in the County of Tyrone. Alternation has its limits also in another sense. It may be possible, for example, that during the whole range of geological deposition, in some particular spot one unvarying mineral deposit may go on, such as sand, to the exclusion of all others; and hence the difficulty of division into epochs will there be insurmountable; but though the appreciation of differences be impracticable, it is certain that the several portions of the sand deposit must coincide with different geological epochs,—one perhaps with the old red, one with the carboniferous, and one with the new red; and that in no case is it possible that strata of one geological formation should alternate with those of another formation not in immediate succession to it.

Keeping these principles in view, I shall proceed to inquire what marks of division can be found in the sandstones of the counties of Derry, Tyrone, and part of Fermanagh, and to explain the nature of the obscurity in which they are partly involved. First taking the succession from above downwards, it has been shown that in the line of section (Pl. A, fig. 3) there occurs a small patch of shales alternating with calcareous grits, one thin layer of which exhibits on its upper surface remains of the remarkable fishes Gyrolepis Albertii, Acrodus minimus, and Saurichthys apicalis, which have on the Continent been considered fossils of the muschelkalk, whilst the shales above it contain numerous impressions of Cardium striatulum, a fossil hitherto confined to the oolitic system; and that proceeding westward from this locality, beds of clay, calcareous grit, and limestone appear, full of the most striking fossils of the lias. It is evident, then, that at this point, the summit of the new red sandstone or the triasic division, is distinctly recognisable. Descending, a thickness of about 400 feet, is passed through, of variegated marl and of a deep red sandstone also variegated with lines and patches of a greenish-grey colour, the greater portion being calcareous, and at its base occasionally highly crystalline. As this deposit is almost in contact with the shales above, the calcareous grits of which possess much of the character of the lighter varieties of the new red sandstone, and there is no break of continuity or marked disturbance of arrangement in any part of it, it cannot be regarded in any other light than as one formation,—the new red sandstone. The sandstones next in succession, at and near Fruit Hill, have already lost much of the deep red and variegated character; but the line of continuity is here, in this section, broken, and it is impossible therefore to explain from it the probable relations between the upper sandstones, and those near the shore of Lough Foyle, in Tamlaght Finlagan, and Faughanvale parishes. The deep red and variegated sandstones and marls of the "new red" can, however, be traced across by the Castle River and Curly Burn to Keady, and thence to the base of Donald's Hill and Benbradagh, nearly in a straight line.

In Mr. Griffith's map the boundary of the new red follows the indented outline of the chalk and basaltic escarpment; but as the irregularity of that outline is due to wear and denudation, and not to original formation, such concentric correspondence is not necessary, and does not apparently here exist. At Benbradagh (Pl. A., fig. 4) the chalk is capped by a thick mass of basalt, and graduating downwards into a thin seam of greensand, is underlaid by the red marl, the thickness of which is between six hundred and seven hundred feet. Of fossils the marl has as yet only produced Posidonomya minuta, a shell which is associated with Palæoniscus catopterus, at Rhone Hill, in Tyrone, and is therefore the more valuable, as it not only exhibits a common character between the deposits at such distant localities, but also assists in establishing the true position of the Rhone Hill strata. To the red marl succeeds a considerable thickness of variegated marls and loosely aggregated sandstones, which, if estimated by the dip, could not be less than one thousand feet thick.

In the immediate line of section no fossil data occur on which the exact limits of the formations can be fixed; but there is a considerable variation in the character of the sandstone, which loses its deep red colour, becomes close grained, is felspathic and micaceous,—sometimes pinkish, sometimes quite white, but subject on exposure to assume ochreous tints or stains; there is, however, a gradation even in this, as the sandstones are at first loosely aggregated, though lighter in colour. The sandstone still continues to be associated with argillaceous beds, sometimes very similar to the marls of the upper sandstone, and sometimes of a reddish-chocolate colour. These sandstones continue with little change, gradually becoming more and more conglomeritic, are then associated with beds of an impure limestone, which is sometimes magnesian, and finally end in the coarse conglomerates which rest on the mica schist,—thus affording a succession of strata so similar to the Trias, Grès bigarré, Grès des Vosges, and Rothe todte-liegende, of the Poikilitic system, that it would be impossible satisfactorily to separate them without the clue afforded by fossils. Or if the base were considered the old red sandstone, it would be equally difficult to decide where that formation should end, if traced upwards in this line of section. South of the section, data for separation may, however, be obtained. In the Hass Townland, one mile east of Dungiven, the sandstone, which is more highly inclined than in the line of section, is associated with soft, shaly, thin micaceous beds, in which were found a few scales of Holoptychius Portlocki (Ag.), whilst immediately above them the grits contain numerous fragments of plants. The strata have probably been thrown up at this place out of their natural level as compared with the strata of the section, and the horizontal distance occupied by the superincumbent strata is therefore less; such a disturbance is also shown in the dip.

There is here, therefore, a distinct indication of carboniferous strata, which is strengthened by the occurrence of numerous fragments of crushed Calamites, probably Calamites nodosus, in a soft red shale, one mile and a quarter west-north-west from the Hass locality and half a mile north of Dungiven, on the stream which passes through the demesne of Pellipar, and between the Newtown Limavady and Garvagh roads; and again, two miles and a half west in Altmover Glen, the shales associated with the grits contain fragments of plants extremely similar to those found in the shales of Ballynascreen and Maghera, as well as some similar to the smaller specimens of the Pellipar locality. A low sandy, or gravelly flat, through which the Roe winds its way, occupies the central portion of Dungiven, and divides the grits and shales, immediately below the red shale with Calamites, from the Altmover grits: if the latter, therefore, are considered the base of the carboniferous strata, it is very probable that the former belong to a higher point in the system, the sandstones, with their shales and marly clays, representing, not merely one member, but probably a very large portion of the carboniferous system, no mountain limestone being here present. The range of the Altmover grits can be traced in a north-east direction until it falls into the line of section. From this point the strata may be followed two miles and a half downwards, in the direction of the line of section, the upper strata being associated with beds of impure nodular limestone, sometimes magnesian; and the lower, as before stated, being rudely conglomeritic, or composed of beds of large water-worn pebbles, which, at the extreme base, are of considerable size. The pebbles are principally quartz, mixed with a few fragments of red jasper. As this great mass, if estimated by the dip, would amount to a thickness of 2500 feet, and has hitherto produced no fossils, I am inclined to believe that it graduates downwards into the old red sandstone, and that the conglomerate beds belong to that formation. The whole extent of the old red thus defined does not exceed a thickness of 1000 feet, and in superficial space is confined to a narrow stripe close to the mica schist. One of the limestone beds of Altmover Glen see Pl. C., fig. 9) is coloured, in the last edition of Mr. Griffith's map, " Lower Limestone;" but if this were correct, all that portion of the sandstone now coloured on the map yellow sandstone, and referred, therefore, to a division below the lower limestone, must necessarily be transferred to the calp, or strata above it. From Benbradagh, the marls of the new red sandstone continue southward, forming an easily decomposable escarpment under the chalk and basalt: they are continued through the townlands of Tirgoland, Curraghlane, and Ballymonan, where they are much diminished in their superficial extent, are interrupted by the basalt in Eden, and then re-appear, of their ordinary thickness, close to the mica schist, which rises up, as it were, and blocks out the secondary strata. The position of the basalt, at this point, is curious and doubtful, and it is impossible to say, with positive certainty, either that the basalt of Eden is connected at a lower level with that of Corick and the White Mountain, so as to form a long narrow projecting tongue, or that the White Mountain, &c., is an isolated and outlying mass. If the summits alone are examined, they appear disunited by denudation; but the basalt occurs in the intervening space at a lower level, and it is not, therefore, impossible that it has either originally sunk deeper into the soft marls at this place, or has subsequently been protruded. On the western face of Corick there is also a thin stripe of the marl, sufficient to mark the existence of Poikilitic strata, which, without it, would be uncertain. In this section it is very difficult, if not impossible, to draw a defined boundary between the new red and the carboniferous sandstones, as the deep red colour is generally absent; it may, however, be observed, that the apparent passage of the one into the other, as respects mineral character, is a strong reason for believing that some portion of the underlying sandstones belong to the upper members of the carboniferous system. The small detached portion of the new red, in Errigal parish, resting on the mica schist, and overlaid by the basalt, is another proof how extensively the secondary strata had been spread out prior to the great overflow of the basalt, as are also the passages of the carboniferous sandstone under the basalt of White Mountain, and again under Carntogher. This latter phenomenon is illustrated by Pl. E., fig. 1. The old red sandstone, in this part of our course, is nearly lost; but coarse conglomerates, coinciding with those of Bovevagh, rest immediately on the upturned schists and limestones of the River Roe, a short distance east of the old Church of Dungiven; and again occur as a small patch, resting on the schists near the barony boundary, at the base of the White Mountain. Passing the dividing ridge between the parishes of Banagher and Dungiven on the one side, and that of Ballynascreen on the other, which is formed by the elevated crest of the underlying and partly concealed mica schist, the carboniferous sandstones are readily determinable by the fossiliferous shales associated with them; but the new red sandstone disappears, the carboniferous grits being either in contact with the basalt, or separated from it only by a thin layer of chalk and flints; a small patch, however, of deep red and earthy grit, which underlies the basalt on the Fallylee River, on the boundary between the parishes of Killelagh and Maghera, seems to me referrible to that formation; and as the carboniferous grits are very near it, proves that the limestone of Desertmartin and Kilcronaghan is wanting, or does not extend very much farther than it has been traced, terminating as abruptly to the north as it does to the south. In respect to the old red sandstone, the case is different, as it occupies a greater space than has been usually assigned to it; it is most distinctly developed in the vale of the Upper Moyola, where it appears as a coarse red conglomerate, alternating with a red earthy sandstone, which, from the looseness and coarseness of their texture, are both easily decomposed, and worn into very irregular forms. That they should be separated from the carboniferous grits, seems undoubted, as well from the circumstance, that at the point where the road from Draperstown to Derrynoyd passes the Moyola, the fossiliferous shales associated with the latter appear, and are quite unconformable to the strata of old red conglomerate on the opposite side of the river, as from the great difference of their mineral characters. They can be traced, without difficulty or obscurity, in a north-east direction, skirting the schist for about four miles, the conglomerates near the contact containing large fragments of the mica schist. It now becomes more difficult to decide their course; as, however, the beds skirting, in like manner, the mica schist of Coolnasillagh, on the north-east, are also highly conglomeritic, are associated with red earthy or marly sandstones, dip from the schists at a high angle, would, if produced, pass under the grits of the lower ground, and though of considerable depth, do not afford a trace of carboniferous fossils, they appear to have every claim to be associated with the old red sandstone. Between these two portions, or that skirting the mica schist of Slieve Doan, and that on the face of Coolnasillagh, there is a gap, the strata of which cannot, with equal certainty, be allocated to this formation; and it is probable that at this point there had been extensive wear of the old red strata prior to the deposition of the carboniferous. The similarity of some portions of this conglomerate to that which underlies the mountain limestone, in Kildress parish, County of Tyrone, is very striking: there the sandy beds become fossiliferous, and thus pass into the carboniferous strata; whilst, in like manner, on the White Water, the conglomerates, which in the vale of the Moyola had been associated with no fossiliferous beds, become interstratified with beds of fossiliferous shale, and thus indicate an approach to the carboniferous strata. If, then, the presence of fossiliferous beds, the fossils being carboniferous, be a reason for transferring one portion of the conglomerates to the carboniferous system, the absence of any fossiliferous strata, for a very considerable thickness, seems an equally cogent reason for placing the other portion in the old red, to which, in every other respect, it has such strong affinity. In these beds sulphate of barytes is also occasionally developed, though not so extensively as in the old conglomerates of Tyrone. In determining the limits of the formation upwards, I have been guided by the appearance of fossiliferous shales, and though, to a certain extent, the boundary line must be arbitrary, it is certainly near the truth. The strata have suffered much degradation prior to the deposition of the carboniferous grits, which renders their outline irregular, and difficult to trace. A small protruding patch occurs near the Moyola, which appears connected with the double dip, or anticlinal bend, of the shales and grits near that spot. The stratigraphical* thickness of the old red in the vale of the Moyola, estimated by the dip, is 2000 feet; but its absolute thickness cannot exceed 200 feet: it has been overlooked, and is coloured mica schist in the last edition of Mr. Griffith's map.

The position occupied by this portion of the grits of the old red and carboniferous strata, will be understood by a conjoint examination of the map, and of Plate D. In the lower of the two views especially, the deep re-entering bay, or vale of Ballynascreen, is clearly shown; and it is easy to imagine the old red penetrating into the valley between Doan and Cullion, and underlying the carboniferous grits, limestone, and shale, then passing round the base of Doan, and skirting that of Craignashoke and Coolnasillagh; whilst the carboniferous grits and shales, with their impure limestones, occupy the greater portion of the low ground, and underlie the carboniferous limestone of Desertmartin and Kilcronaghan. In endeavouring to discover data for separating the old red from the superjacent strata, a remarkable fact becomes apparent; that, whilst the grits and great band of shales, which extend from south to north—from Ballynascreen to Maghera—have an eastern dip, are partially unconformable to the old red, and underlie the Desertmartin limestone, the shales of the White Water River are conformable to the underlying old red, alternate with, and are covered by conglomerate beds, which still preserve the typical character of the old red, and conformably underlie the elevated limestone of Cullion, which is entirely separated from that of Desertmartin. The presence of Dithyrocaris Colei and D. orbicularis, &c., in the shale, seems to mark it out as belonging to the carboniferous epoch, notwithstanding the prevailing mineral character of the sandstones. The old red again appears on the northern base of Slieve Gallion, of considerable thickness, possessing the usual character of coarse conglomerates alternating with red earthy sandstones; and it forms also a narrow belt, skirting a portion of the metamorphic and granitic rocks. It is here that some of the finest examples of metamorphic action may be studied, the earthy or marly grits passing, by almost insensible gradations, into a granitiform rock, so that it may be reasonably doubted where the originally igneous rock begins, and the metamorphic secondary strata end: these effects, however, will be more fully detailed in the next chapter. The old red, on the northern face of Slieve Gallion, dips at a high angle (about 30°) to the north, passes under the carboniferous strata of Cullion, and, with the more northern portion of the old red, which dips to the south, includes them in a trough or basin. That the old red within this space has undergone great degradation prior to the deposition of the carboniferous strata, cannot be doubted, when the irregularity of its outline is considered, as well as its present existence under a portion of the newer strata, as shown by the denudation of the small patch west of the Black-hill school-house.

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* This word is used to designate the thickness of successive beds, as shown by a section; for though, in some cases, such beds may be continued downwards, so as to give an equal vertical thickness, in the great majority of cases they are not, and the absolute thickness is very small, compared to the stratigraphical. For example, in the vale of the Moyola, the position of the mica schist on each side shows that the trough within which the old red strata had been deposited, must be extremely shallow, although the thickness, estimated by the successive beds, would be considerable.

Between the old red and new red strata east of the granitiform rocks of Slieve Gallion, it is difficult to draw a decided line of demarcation. If viewed in extreme examples, the bright red tints of the sandstones and marls of the new red are strongly contrasted with the dull reds of the older strata; but under the influence of metamorphic change this distinction becomes doubtful. The lower portion of the new red is pebbly, and less distinguished from the old red than in situations where they are seen far removed from each other, and no intervening fossiliferous strata here separate them, on which account I was originally disposed to place a larger portion of the grits and marls, dipping to the eastward, in the new red, and to ascribe the augmentation of dip, exhibited in Plate E., fig. 3, to the disturbances accompanying metamorphic action; but taking into account the difference of mineral character, and the correspondence of the lower portion with the tilestones and grits of the mass dipping to the north, and therefore transverse to the section, I have extended the old red considerably farther, though it is not impossible that some portion ought to be placed in the intermediate or carboniferous strata. It could not be expected that extensive metamorphic action should have been exhibited without some disturbance, and such is strikingly displayed in the interior of this portion of the tilestone grits, as, on approaching the axis, partial, but very marked unconformability is remarked, just as if the strata had been dislocated and displaced by internal movements: that they have also been, in part, elevated, seems probable from the condition of the carboniferous shale at their northern base, which is highly inclined, whilst a small portion of it unconformably overlies the edges of the elevated grits; but although this is reasonable, and would appear to afford a very natural explanation of the elevated position of the limestone of Cullion, a difficulty arises in the fact, which will be again the subject of consideration in the carboniferous chapter, that the shales and grits of the White Water form, with the upper conglomerate beds, a regular and apparently undisturbed escarpment.

Having thus endeavoured to separate from the great mass of sandstones, which occupy so large a space in Derry, those portions which may, with some reason, be allocated either to the underlying old red, or to the overlying new red, the intermediate carboniferous grits will be described in Chapter XII. The subdivision of this portion of the old red, or its identification with any particular member of the formation in England or Scotland, is attended with great difficulty, as there are here no marked outcropping ridges by which one section of its beds may be separated from the other. If, however, a comparison be made with the great mass of the formation, as developed in Tyrone and Fermanagh, it would seem probable that the beds in Derry belong rather to the upper members of the system, and graduate upwards into the carboniferous strata, whilst a large portion of the old red strata of Tyrone and Fermanagh belong to the lower members, and graduate downwards into the silurian; nor is it improbable that some of the impure limestone beds, associated with the sandstones, represent the corn-stones of the old red, rather than the regular beds of the mountain limestone, though as yet no fossil data, of which I am aware, have been found to decide the question. In Derry, therefore, the old red consists of coarse red conglomerates, alternating with earthy sandstones and marls of a dull red colour, or of sandstones and conglomerates of a more regular structure, and variable in colour from dirty red to pinkish, which are associated with beds of impure limestone. These pass into the carboniferous strata, and in the want of any strongly marked outcrop, it is sometimes impossible to draw a line of separation, unless where the presence of fossiliferous shales indicates that the boundary between the two formations has been passed. Sulphate of barytes is occasionally present, and it will be found to abound in the old red strata of Tyrone. Entering that county, the mountain limestone is well developed in the parish of Derryloran, and, in consequence, the underlying and overlying sandstones are there satisfactorily separated; but the question again arises, what portion of the grits and conglomerates belong to the old red sandstone? and it is one of considerable difficulty. The limestone, which may be traced along the road to Stewartstown, as portions of a broken ridge, having an eastern dip, is bent round to the west at Cookstown, and re-appears at Cove Bridge, near Lissan, with which it is probably continuous. Within this internal belt, transverse ridges of limestone, equally broken and very irregular, occur, and the intervening spaces, which in Derryloran and Kildress are flats occupied by brick-clay, afford no evidence of any connection between them, and increase the difficulty of deciding on such isolated deposits, the clay itself having no correspondence with any bed in the carboniferous strata. West of the Church of Cookstown, about half a mile, the Kildress River has cut through and exposed a deposit of red and pinkish grits alternating with conglomerates, which underlies the great belt of limestone, the upper beds becoming calcareous, and ending in impure limestone. Here, then, is a distinct passage from an underlying grit, and I am disposed, therefore, to place the grits and conglomerates in the old red; but there is a difficulty in the detached and isolated portion of limestone, which appears higher up on the same river. On examining that limestone, it is observed to pass downwards into a red grit full of fossils—some carboniferous (such as Orthis crenistria), and others doubtful; and then again the grit loses its fossils, and becomes conglomeritic. It seems, therefore, a case similar to the one in Derryloran already mentioned, and the limestone itself appears an outlying mass, within the limits of the old red. The interstratification of deep red shales, with the limestone, occurs also in the Shivey limestone. It is probable, therefore, that here, as in the County of Derry, the old red strata have suffered extensive wear, and that the superjacent strata have, in part, been formed of its detritus, assimilating the lower carboniferous members, as in Cullion, Derryloran, and Kildress, to its own characters. In this complicated and obscure locality, the last edition (1842) of Mr. Griffith's map is probably less accurate than the first. What is here considered the upper portion of the old red, is represented by Mr. Griffith as the yellow sandstone; and if the original definition of that geological division were preserved, namely, the upper beds of the old red alternating with the lower of the carboniferous, the difference would be merely a difference of terms, though the strata here classed with the yellow sandstone are totally distinct from those so called in the parishes of Carnteel, Clogher, &c., both in mineral character and geological position. The alterations made in the relative positions of the yellow sandstone and limestone in the two maps are of a different kind, and the first map appears to be the most correct, though a portion of calcareous grit associated with the limestones has in it, as well as in the last, been confounded with the underlying sandstones, the yellow sandstone being thus placed above and below a distinct member of the mountain limestone, which is contrary to the terms of its definition.

In the parish of Desertcreat, the old red sandstone is more distinctly marked, and a portion of it assumes a character so different from the rest, that a subdivision seems naturally marked out. It loses the red colour, is of a dusky grey tint, has numerous specks of mica, and is frequently hard and flaggy. These characters prevail over a large extent of country, and are especially marked along the principal axis of elevation of the formation, passing through Tyrone and Fermanagh. The conglomerate beds partake of the same characters. The gritty bed, which is the last with fossils, in ascending succession of the silurian strata, resembles this portion of the old red; and as there is an alternation of the schists and conglomerates at Lisbellaw, in Fermanagh, and a conformable superposition of the conglomerate on the schist in Desertcreat, I think it not improbable that some of these sandstones actually belong to the silurian strata, and represent the deficient portions of that system; but it is impossible to draw a line of demarcation in strata not sufficiently separated by either mineral or fossil data.

In the western portion of Desertcreat, and in the adjacent parish of Pomeroy, occurs the silurian district already described; and in immediate connection with that formation, the lower or doubtful portion of the grits is strongly marked, and, taken alone, would appear very distinct from the more recent portion. They are massive, much indurated, and fall in the line of strike of the schists. This is more particularly the case at the quarry south of the town of Pomeroy, and at Cavanakeeran and Tremogue, to the west of it, where the sandstone has passed westward along the base of the sienitic and greenstone range, though it now appears only in patches, having been cut away, as is seen from the deep ravines now obscured by detritus; the actual dip of the strata is not determinable. The same sandstone occurs also in the prolongation of the strike of the schists eastward; it is very similar to the thin sandstone beds which occasionally occur in the schists, and which become fossiliferous at the extreme southern point of the silurian deposit. This similarity of character adds to the probability of a portion of the lower sandstone belonging to the silurian strata; and when it is considered that all the beds of schists are not fossiliferous, even in the same line of section, it ceases to be surprising that a small part only of the sandstones should be so. The combination of peculiar circumstances must have operated on the distribution of organic bodies at all former zoological periods, just as it would operate in the present. If this view, therefore, be correct, I should be inclined, as already suggested, to include in the silurian strata a portion of the overlying sandstone, though the exact proportion must, to a certain extent, be arbitrarily determined; and on this principle it may be supposed that the prevailing deposition of argillaceous, or muddy matter, in the schists, has been a local circumstance, and induced a corresponding abundance of organic remains. Advancing in the line of dip, the same mineral character is preserved, though the sandstone flags acquire a dull reddish or faint mulberry tint, occasionally variegated with greenish bands, and sometimes containing lumps of red clay. In the south of Pomeroy, part of Donaghmore and Killeeshil, there is a great development of the old red strata, the lower portion possessing the sandstone flag character, though with many shades of variation, approximating it to the ordinary red sandstones, and terminating both in the line of dip, and at the edges in the line of strike in sandstones and conglomerates, corresponding to those of Derry; the strata are intersected by numerous ravines, and the surface of a large portion of the country is upland, boggy, and dreary, though capable of great improvement.—(See, for example, the district of Altmore.) Within this great space, through which a section five miles long might be drawn, the strata, wherever it is possible to ascertain it, still dip to the southward, the dip in the northern portion, or that contiguous to the silurian strata, being considerably greater than in the southern portion. In the latter it is small, from 9° to 12°, and it is probable, therefore, that the total stratigraphical thickness, estimated by dip, would not exceed 5000 feet. In the south of Killeeshil, there is a synclinal line, and the strata south of it rise to the south or dip to the north; they are exactly similar in character to those on the north of the line, corresponding to the upper, or Derry division of the old red, and continued to the south-west, form the curious spit, which is separated from the more northern mass by overlying shales and limestones of the carboniferous epoch. As there is no fossil evidence in any portion of these strata of having passed the line between the old red and the carboniferous formation, it does not appear possible to place any of the red grits or conglomerates in the yellow sandstone of Mr. Griffith, unless it be considered a portion of the old red, a sense in which the term seems to have been used in Scotland. The town of Augher lies in the space between the northern mass and the southern spit of the old red, which is a flat, occasionally boggy, with limestone knolls, and here and there a small lake, or lake-like opening, characters very common in limestone and shale districts, and well exhibited on the new road from Ballygawley to Clogher. The sandstone district from Pomeroy to Killeeshil is remarkable for the great development within it of felspathic rocks, which form the mass of Barrack Mountain, Cappagh, and Sentry Box; and similar rocks again appear near Ballygawley. The occurrence of porphyries, in the new red sandstone, is not unusual, and is justly ascribed to metamorphic action: to the same action must also be attributed the felspathic, or petrosiliceous rocks of this district; and in proof of it may be cited another phenomenon of the district—the porphyritic character of some of the conglomerates. This remarkable condition of the conglomerates, and their intimate connection with the felspar porphyries, are beautifully seen on the little river which separates the townlands of Crannogue and Knocknaclogha, north of Cappagh Mountain. The partly variegated sandstones are seen below, and are succeeded, first by beds of conglomerates, which become porphyritic, and contain pebbles of porphyry; and then by felspar porphyry, which rises to the top of Cappagh. At one point the porphyry seems to descend into the conglomerate, and has much the appearance of a dyke traversing it. The bedding of the conglomerate is here lost, and it becomes a confused mass, as if blending into the porphyry, which appears in its ordinary condition above it. A due examination, however, detects appearances so similar to the ordinary effects of trap dykes, that it can scarcely be doubted that the basaltic and amygdaloidal dyke or mass which abuts against the porphyry at about 400 yards to the south-east, has extended to this spot. Immediately opposite to the apparent dyke and in the river bed is a thin copper lode, the direction of which is nearly north and south; it is only visible for about ten feet, and its probable extent or importance cannot therefore be determined until the ground has been more opened, which will be done by the Hibernian Mining Company: it is, however, remarkable that it should correspond so nearly to the direction of the basaltic dyke, which, though rather irregular, appears to run from south-south-east to north-north-west. It might have been expected that so powerful an effect as is exhibited in these felspathic rocks could not have been produced without great disturbance of the strata; but in the principal deposits of Desertcreat and Killeeshil, all seems to have been tranquilly effected; the dips of the sandstone strata remain regular and undisturbed, and some portions of the felspar porphyries are probably arranged conformably to the sandstones. Such are cases of difficulty common to all metamorphic rocks, from the hornblendic schists, interstratified with the unaltered mica or clay schists, to the felspathic porphyries, associated with the sandstones, and they seem to require the intervention of some other modifying cause, such as the deposition of volcanic matter, or mud, amongst the ordinary strata, as well as the changes subsequently produced by metamorphic action. This cause has been extensively applied by Mr. Murchison in the volcanic dust of the silurian system, and, without doubt, it is equally applicable here. In the vicinity of the felspathic rocks of Ballygawley, the case is different; and the strata, by their high inclination, and the altered direction of their dip, show that they have suffered very considerable disturbance; they are penetrated by veins of sulphate of barytes. Porphyritic conglomerates are also met with in the vicinity of Ballygawley; and, considering them as only a less marked degree of metamorphic change, they form one of a beautiful series of facts, illustrative of a doctrine which has done much to clear up the obscurity of geological phenomena.

In considering the nature and extent of these changes, it appears that the petrosiliceous rocks of Pomeroy have arrived at the most complete alteration of structure, small crystalline particles of glassy felspar being developed within their substance, and approximating them to the rock of Shane Hill, near Lurgan, and to the trachytic porphyries of Armagh, Down, Antrim, and Donegal. In their colour, which is dark, they agree better with the Shane Hill rock, which is at the outskirt of the basaltic field, whilst the trachytic porphyry of Antrim is within its limits, the origin of the present condition of both, if metamorphic, being naturally attributable to the influence of causes in connection with that erupted rock; but the petrosilex of Fork Hill, County of Armagh, and the trachyte of the County of Down, are not visibly connected with basaltic phenomena, the one occurring within the area of the transition schists, and the other on the verge of a granitic district. This peculiar position renders them more illustrative of the present district, in which the principal porphyritic or petrosiliceous masses are in the vicinity of a line of granitic and hornblendic rocks, as is the case at Fork Hill; and if such relation throw some light on the Tyrone rocks, it cannot be doubted that the latter will equally elucidate the former. In the sienitic range, there are so many gradations of change, from the rock which appears decidedly granitic into hornblendic rocks on the one hand, and into others which are little more than schists, in which the constituents have been blended together, and the stratification obliterated, that the mind seems forced to consider the whole, even to the granite, as metamorphic; whilst, in a similar manner, the felspathic grits and conglomerates exhibit similar gradations, the crystalline particles of felspar losing their individuality, and the arenaceous paste becoming smooth and even, until the result is a homogeneous felspathic rock, or a felspathic porphyry. As, therefore, the hornblendic and sienitic rocks, as well as the felspathic porphyries, must be considered metamorphic, they can only be looked upon as effects of the same cause acting upon both, and not as cause and effect to each other. That cause was internal, and its nature is rendered evident by the numerous trap dykes which, traversing the great mass of the old red sandstone, have, in some places, all the characters of a basaltic greenstone, containing even the characteristic basaltic minerals; and are found possessing the same characters within the porphyry itself.

Having thus briefly noted the circumstances of these curious deposits, any further remarks on them will be reserved till the next chapter; but it should be mentioned that sulphate of barytes occurs in small quantities in the felspathic porphyry of Pomeroy, and more largely in that of Errigal Keerogue, the rocks being here, however, of a less modified variety; and as similar veins occur in the older grits, can it be possible that the mineral has remained unaltered, whilst the sandstone itself has passed through the metamorphic change? The arrangement of the sandstones, in the latter locality, is very curious. Those to the east of the porphyry preserve the southern dip of the more northern portion, but in the vicinity of the porphyry it has much increased, varying from 24° to more than 40°. On the western side they dip to the west, a small portion only at the extreme south retaining a southern dip. The western sandstones have the character, strongly marked, of the lower, or silurian division of the old red, and the eastern and southern of the upper, or carboniferous; but there are so many links of connection between them, in mineral character, that it is evident they both belong to the same system. A small portion of carboniferous sandstone, with fossils, also occurs here, but its mineral characters and its dip are quite distinct from those of the adjacent older grits. In following the line of the old red from Errigal Keerogue into Clogher, the principal division preserves the north-west dip and south-west strike, which it possessed in the vicinity of the Ballygawley porphyry; and in Lumford's Glen, near Killyfaddy, the sandstone appears as a bold mass, not readily distinguishable as to dip or direction, and traces of igneous action are there also discoverable in a nodular clay-like trap, associated with the grits. The porphyritic character of the conglomerates still continues, and the mass is traversed by a highly crystalline greenstone dyke, which can be traced in a west-north-west direction for many miles; its eastern end is about a mile north-west of Daisy Hill, and nearly due north of Aughintain Castle, but by detached lumps it may be carried on to Clogher. It is not perfectly straight, but in part waved. To the north of the dyke, the strata preserve the south-west strike and north-west dip with tolerable regularity; the conglomerates have a uniform paste and a porphyritic character, and are occasionally associated with dull red and green mottled earthy grits: to the south of the dyke, the strata are confused, and variable in their dips, but the principal portion has a southern and regular dip. In character, it approximates to the newer section of the old red, consisting of red and mottled conglomerates, with earthy sandstones; and it is remarkable that, at the junction with the carboniferous strata, the conglomerates are entirely quartzose, and have lost their red colour. In this portion, therefore, the transition or intermediate formation, such as the yellow sandstone, is the base of the carboniferous strata, being marked by shales and beds of impure limestone, and at Edergole by a small patch of fossiliferous grit, partly conglomeritic, as above observed, and shales. The section, Plate G., figs. 4, 5, exhibits the probable connection and effect of the dykes. Following the grits to the county boundary, the same general characters are preserved, though the distinction between the two sections of the formation is less marked, both approximating to the newer: there is, however, no confusion with the carboniferous strata, which are almost in contact with them.

In the northern portion of the parish of Enniskillen a line can be drawn with tolerable precision between the older and newer sections of the old red, the older preserving a uniform strike to the south-west and a north-west dip; whilst the newer to the south-east of the line has a variable dip, as if, in part, forming a knoll or bank, surrounded by the shales and limestones of the carboniferous epoch, and penetrated by numerous trap dykes; the dip is small, and the mass is therefore nearly horizontal. The old grits preserve the same indurated or close grained, flag-like character, and dull red or reddish-grey tint, and form some of the principal hills of this portion of the district, such as Brougher, 1076, and Topped, 909. Some of the sandstones are micaceous and sandy, and others, as well as the paste of the conglomerates, highly felspathic, and tending to become porphyritic, which is the case in Brougher, the extreme minuteness of the particles facilitating metamorphic change. The south-eastern boundary of the old red sandstone is now well marked, and is continued by the town of Tempo and Lough Eyes towards Lisbellaw, where the silurian strata, which had been noticed as connected with, or underlying, the old red in Pomeroy and Desertcreat, again appear underlying and alternating with conglomerates, which ultimately pass into the old red formation. The strata are here conformed to an anticlinal line, and dip in opposite directions from the silurian nucleus; they have very little extension in a south-east direction, but to the north-west the section of the old red continues for many miles. A small portion of the newer section of the old red skirts the south-western edge of the silurian and old red, is unconformable to them, and dips under the shales and grits of the carboniferous system. The western boundary of this great formation can now be traced in nearly a straight line east of Lough Erne, through the parishes of Magheracross and Derryvullan; the southern portion is broken into successive hillocks, but in the northern it falls into low ground, and as the dip varies, being in some places reversed, it is evident that the stratigraphical thickness of the formation will be correctly estimated by the southern part taken alone, or by a section of about five miles, instead of one of about eleven miles, and even then it is considerable, probably 8000 feet. To the north, in Magheraculmoney parish, the grits and conglomerates are again seen in a well defined band, stretching east and west, but they correspond more to the newer section, the conglomerates being largely quartzose; these extend to the mica schist, are massive in character, and disposed in part to an anticlinal line, dipping, in the western portion of their course, northward at a high angle, towards the carboniferous strata, and, in the eastern part, to the south, or from the mica schist, and also at a high angle. Between this and the mica schist of Donegal is interposed an extensive space occupied by carboniferous strata, with the exception of a narrow band of the second division of the old red, which rests immediately on the mica schist. This band is in some places, as in Templecarn parish, reduced to a mere stripe, Pl. G., fig. 6, and dips at a high angle from the mica schist. It is succeeded by a light coloured quartzose conglomerate, and by sandstones and shales alternating with each other, thus affording another example similar to that of the White Water, Derry, of the base of the carboniferous system possessing similar characters to the upper section of the old red, and also showing that if a division can be here effected between them, so ought it to be established under the same conditions in Ballynascreen, Maghera, Dungiven, and other localities.

The limitation of our inquiries has prevented me from, at present, following out the line of the old red to the eastward of this point, and separating those portions from the yellow sandstone of Mr. Griffith, which either belong to the underlying old red on the one hand, or on the other to grits which are geologically above a well-defined member of the carboniferous system: at present, therefore, I can only state my conviction that such alteration is necessary. The detached patch of grits, extending from Gortin towards Strabane, has only been noticed at its eastern extremity, where it consists of red sandstones, interstratified with reddish crumbly shales, corresponding to the old red of Ballynascreen, and specially in position to the projecting neck of the Moyola vale; this, then, I remove from the yellow to the old red sandstone; whilst near Killyclogher is observed a series of grits and shales, with fossils corresponding exactly to that of the White Water in Ballynascreen, though resting immediately on the mica schist, and also at the town of Omagh.

Returning now to the new red sandstone, in the parish of Desertlyn (County of Derry), it is restricted in the line of section (Plate E., fig. 3) to that portion which, if continued, would correspond to the elevated and outlying patch underlying the chalk and basalt of Slieve Gallion Carn, and separated from it by a valley of denudation. It is difficult to draw the line of separation, or to determine whether any of the beds belong to the carboniferous strata; but the probability is, that the old red is here directly overlaid by the new. To the north, it can only be placed conjecturally between the carboniferous limestone and the basalt, in contact with which it appears near Maghera; and, judging from the character of the detritus, it is even probable that a part of this space should be occupied by the upper carboniferous grits. If traced southward by the line of marly beds, its boundary would be a nearly straight line extending to Killymoon demesne, where it is almost in contact with the carboniferous limestone strata; but within this line, towards Lissan, there is a triangular space, lying to the west of the road from Moneymore to Cookstown, which either belongs to the lower portion of the new red, or to some part of the carboniferous strata, the variations in the sandy detritus corresponding to this supposition; it is underlaid, at Cove Bridge, by carboniferous limestone and alternating grits, and the locality seems one which requires investigation by boring, and might be expected to exhibit carboniferous strata, as it should be kept in view that the Coal Island deposit is, in like manner, still in part covered by the new red sandstone. From Killymoon, it can be traced to Stewartstown, where denudation has exposed the underlying and unconformable strata of the mountain limestone below it, and separated the principal mass from a basaltic capped outlier west of the town; it underlies the chalk and basalt east of the town, and penetrates into a denudation within it. Thence it had passed over the coal district of Clonoe, but has been principally removed by denudation, and by Killyman parish and Rhone Hill, where Palæoniscus catopterus and Posidonomya minuta were first discovered, through Clonfeacle and Aghaloo to the vicinity of Caledon, where it appears to terminate. The relative extension of the new red sandstone, chalk, and basalt from Moneymore to Stewartstown is represented so differently on Mr. Griffith's map from the view taken of it in the map which accompanies this report, that a more special explanation is necessary. Much of the country being obscured by detritus, the masses of which are more prominent than those of the regular strata, the physical features of distinction are overpowered, and it becomes very difficult to determine the limits of strata in spaces where they are not visible; still, however, there is some evidence for the view taken in this respect. The probable outcropping boundary of the new red has been already sketched, and corresponds more nearly with Mr. Griffith's lines than the indipping boundary, as the chalk in Mr. Griffith's map extends over a large space occupied in our map by new red sandstone. Proceeding from Moneymore, the chalk, forty-five feet thick at the great quarry of Spring Hill, has been cut through, and is observed to rest in part directly on the new red, and in part to be separated by a hard, yellow, semi-crystalline, and probably dolomitic grit six inches thick, and a thin bed of whitish and soft grit, no distinctly marked greensand being here visible. The chalk is highly indurated and splintery at the very bottom, and contains small lumps of dark ochreous matter, very similar to what has been noticed at the upper contact with the basalt. The new red sandstone underlying the chalk forms the base of this elevated ridge, and can be traced to Coagh, where its marly beds appear on the bank of the Ballinderry River below the town, and can be traced in a drain or ditch at the skirt of the wood up to a characteristic junction with the basalt: the general line of the new red and chalk seems therefore well marked up to that point. West, however, of the road from Spring Hill to Coagh, a small patch of chalk denuded on the indip appears entirely separated from the main escarpment; and again west of Coagh a distinct, but very limited, outcrop, underlaid by the new red, and overlaid by amygdaloidal trap. This repetition of the chalk on the same line of section is probably due to a partial elevation of the principal escarpment, an idea supported by the probable existence of trap rocks under some portion of the chalk at Spring Hill, by the phenomena of the Tamlaght dyke, and by the mass of greenstone at the Coagh Bridge. Such elevation, accompanied by denudation, has altered the principal escarpment of the chalk, and given a greater superficial extent to the underlying new red. So far then as this point there is distinct evidence of the correctness of our outline, and for much also of the remaining portion there is indirect, though not direct, evidence, namely, the character of the detritus and the appearance of the country. At Artrea and Leck the deep red grits of the lower portion of the system appear, but eastward of this line there is a comparative flat, the sands and clays of which all indicate their origin as detritus from the new red, if not from the carboniferous grits and marls. The houses are often built of clay, and the boulders and small field stones when they occur are basaltic; but there is nothing to indicate the presence of chalk. The other portions of this disputed territory are not so easily settled, but it would seem most probable that in the principal portion of it, the claims to be arranged are those of the new red and basalt —not of the chalk and basalt,—the former of which therefore appears to have obtained an undue extension in this district. On the eastern side, its boundary follows the line of chalk and basalt by Moneymore and Coagh, until it is finally lost under the basalt; and from Coal Island it can only be determined arbitrarily up to the county boundary. From Grange Meeting-house, by Moy to Benburb, it has been worn away in a very remarkable manner; and at Benburb, alternating beds of shale, limestone, and grit, of the carboniferous system, are, in consequence, exposed to view, the limestone continuing, at intervals, up to Grange, being surrounded by the new red. In all this space, the grits preserve, in a very remarkable manner, the deep brick-red colour which characterizes the formation in Derry, in Dungiven, Balteagh, and Drumachose parishes; and the marls also are red.

In the descending order, the carboniferous grit of Edendork, two miles north of Dungannon, distinguished by the most marked carboniferous vegetable fossils, retains the red colour, just as the red shale with Calamites, near Dungiven, has also done; and as in the ascending order the red colour of the old red grits and marls continues into the lower portion of the carboniferous strata, it becomes the more improbable that the white grits with ochreous stains, of Tullyniskan, Clonfeacle, Carnteel, Aghaloo, Clogher, and of several parts of Fermanagh, should have any connection with the bottom or top of the carboniferous system, and the arguments which have been, and will be urged for placing them in an intermediate section of the formation are thereby supported. I have dwelt upon this subject the more frequently, because the reasonings which have been founded on the fossils of the yellow sandstone are materially affected by it, and must be abandoned should it be proved that strata in very distinct geological positions have been classed together under that name, and the fossils of beds high up in the carboniferous system associated with those of others at its base.

I shall again briefly revert to some of the difficulties which have been already in part noticed. On the north face of the schists in Derry, at Muff, a small patch of coarse conglomerate occurs, which is allocated to the old red, but it is impossible to decide with certainty whether some portion of the grits and fine conglomerates which fill up each indentation of the schists, and extend to Culmore and Muff on the Donegal side of Lough Foyle, should not be also so placed. Some of the conglomerates strongly resemble those of the old red, but the greater portion is finer, and the sandstones, though generally red, are sometimes white, and occasionally so loosely aggregated as to fall into sand. The lithological characters are therefore insufficient of themselves, and as the sandstones approximate more to the carboniferous than to the old red, and more especially to some forms of the millstone grit, it has appeared advisable to place them in that formation. In Dungiven again, the difficulty of division has been considerable, the nodular impure limestone having, perhaps, a greater analogy to the cornstones of the old red, than to the limestones of the carboniferous; still, as they are ultimately associated in some cases with beds containing plants, it seems best to leave them in the carboniferous formation, more particularly as it is probable that the mineral type of associated beds of impure limestone has passed up from the old red into that formation. In Ballynascreen, Maghera, &c., there is also an occasional difficulty in deciding the limits of the old red, though the existence of the formation, when the strata of these localities are compared with those of other districts, cannot be doubted. In Derryloran and Kildress there is also some difficulty, but generally in Tyrone and Fermanagh the limits of the old red formation as a whole, as well as of its two sections, can be traced with tolerable precision. In comparing the map with the sections, if the reader keep a piece of card in his hand, and place it in the direction as respects the line of section indicated by the arrows, he will at once perceive the actual position of the strata relatively to each other. In Plate A., fig. 4, the section is in the direction of the dip, and the nodular limestone represented at its base indicates that portion of the beds which have been described as partaking of an intermediate character, the limestones having an equal, if not a greater, analogy to the cornstones of the old red sandstone, than to the regular beds of the mountain limestone. The exact nature or origin of these beds it is difficult to decide, but they seem an extension of what is observed more generally in the smaller calcareous nodules which occur in the sandstones, sometimes irregularly, but more generally arranged in beds; whether they are merely formed of calcareous matter, which has been separated from the paste, usually calcareous, of the sandstones, and segregated together, or have had an indirect animal origin, I have not, at present, been able to determine. No large fossils have been found, nor as yet has the microscope discovered any of the minuter infusoria or foraminifera. These beds do not occur in the older section of the formation, and would, therefore, be characteristic here, as well as in England and Scotland, of the newer. In Plate F., fig. 3, the section passes through the coarse conglomerates and earthy sandstones of the Moyola River, the conglomerates here, as well as in Maghera, containing pebbles of the mica schist, on which they rest, and abutting against the edges of its strata, which dip in the opposite direction. In several places from the Moyola vale along the line of the conglomerate, towards the Draperstown and Dungiven road, this rock can be studied to advantage, and the pebbles are seen to increase in size, on approaching the schists, until they become very large, some 18 inches, or more, in length, being irregular in form, and indicating a local origin. On approaching the metamorphic rocks of Slieve Gallion, a portion of carboniferous strata is represented. Here, shales and thin impure calcareous layers are associated with conglomerate beds, which have lost the deep red colour of the underlying beds, and are essentially quartzose. The fossils are, in part, peculiar to the locality; but others, as the crustacea, are probably carboniferous, and the evidence seems, therefore, in favor of the latter, though the lithological type of part of the old red continues beyond it, and the limestone of Cullion, like that of Kildress, alternates with beds of conglomerate. In Plate G., fig. 4, the older section of the old red dips northward, whilst the newer section dips southward, and this contrasted arrangement can be observed in several other localities, where the newer formation skirts the outcrop of the older, as has been already noticed. The newer beds have, comparatively to the older, a very feeble development. In Plate G., fig. 5, the strata of the lower old red have, in part, been disturbed and thrown up by the greenstone dyke, so that here a portion of the lower, as well as the more recent strata, have a reversed or southern dip. Both these sections pass through an extensive mass of shales and sandstones belonging to the carboniferous system, the portion to the right hand, or south, of each, being classed by Mr. Griffith in the yellow sandstone. This sandstone, though very compact, is occasionally separated by thin layers of shale, rich in characteristic carboniferous fossils, and contains also, occasionally, vegetable fossils; it is underlaid on the south by shales and limestones, corresponds to the shales and sandstones which overlie the true mountain limestone of

Cullion, and cannot be considered, in any respect, similar either to the strata on the left or north of the sections, or to the sandstones and conglomerates of the Kildress River. The latter might be viewed as beds of transition from the old red to the mountain limestone; the former never could; and it is probable, therefore, that two different things have been here confounded together. In Plate G., fig. 6, a narrow stripe of the old red sandstone and conglomerate, corresponding to the newer section, is seen resting on the mica schist of Donegal, and is succeeded by sandstones and conglomerates partaking more of the carboniferous type, and placed by Mr. Griffith in the yellow sandstone; they evidently occupy a transition position, and correspond, therefore, to the original definition of that sub-formation.

The section then passes through a large extent of carboniferous sandstones, shales, and limestones, a portion of which, containing thin seams of coal, was classed by Mr. Griffith, prior to the last edition of his map, in the millstone grit, and subsequently in the calp, although there is every reason to believe that it is identical with those patches of grits and shales, in Carnteel, &c., which have been called yellow sandstone, and with the sandstone, of which, indeed, it appears a continuation, of Boa and Hare islands, on Lough Erne, also called yellow sandstone. Beyond the boundary of the parishes of Magheraculmoney and Derryvullan, the section enters again on the great deposit of arenaceous strata, which, from the similarity of lithological type, as well as the proofs afforded occasionally, by order of super-position, must be classed with the lower members of the old red: it continues up to the anticlinal line, formed by a small silurian nucleus of schists, where the strata are reversed, and dip under the carboniferous strata. In respect to the new red, its relations may be followed out in the various sections of Pl. A., and in Pl. E., fig. 3, which shows the great valley of denudation by which the new red sandstone, chalk, and basalt of Slieve Gallion Carn, is separated from the strata on the right of the section, and left as an isolated patch on the summit of the metamorphic hill. In Plate F., its general and relative positions may be readily traced; and in Plate G., fig. 1, is shown its remarkable position, resting unconformably on the mountain limestone, and underlying the chalk of Crewe Hill, near Stewartstown. In the view from the Pillar-stone, near Dungiven (Plate B.), the curious bay-like character produced by the wear of the softer strata, and the breaking down of the chalk and basaltic cliffs, is represented, and, from the nature of the strata, where any appear, it is assumed that the new red strata occupy a large portion of this bay, the carboniferous grits cropping out from beneath them. In respect to the mineral character of the sandstones, conglomerates, and marls, which enter into the composition of both these formations, it may be added to what has already been stated, that a large portion of the micaceous flag sandstones of the old red are highly calcareous, but that the sandstones and conglomerates, which occur along the principal culminating ridge, lose that character,—are highly felspathic, the felspar being in very minute crystals, and the paste generally so very fine, that some specimens might be taken for a compound crystalline rock. It is not, therefore, surprising that it should pass readily into porphyries. At Shantavny and Brougher are good examples of the hard felspathic sandstone. The conglomerates of the older division contain primary pebbles, some of which appear to have suffered change; and where the paste has assumed a homogeneous or porphyritic aspect, the rock has often a slag-like appearance, which is very remarkable. The mottled marls, occurring in the sandstones, are highly calcareous, sometimes becoming an impure limestone ; and seams of carbonate of lime occasionally traverse the sandstones. The conglomerates of Maghera and Ballynascreen also contain primary pebbles, consisting of the mica schist close to them, and the sandstones are more or less calcareous. Of the new red, the marls are often very rich in lime, but this is variable. They are often curiously mottled or striated with green or greenish-grey, and twisted in a very remarkable manner, the soft marls conforming to the harder gritty beds associated with them, Plate C., fig. 2. The sandstones are also variable in colour, but the red, of a brick-like hue, is the prevailing tint. Cross lamination is not unfrequent, producing sandstone flags in a direction transverse to the stratification, with smooth micaceous surfaces, Plate C., fig. 19.

Taking these remarks into consideration, it is easy to judge that the soil of the country depending on these rocks, must possess good qualities, though subject to considerable modifications. The highly felspathic sandstones, when connected with marls, produce, from their ready decomposition, a very rich soil ; and the calcareous sandstones must, in like manner, produce a favorable soil: it is, indeed, undoubted that much improvement might be effected by simply attending to the outcrop of the marly beds, and using them as manure in the more sandy. The same remarks apply to the new red sandstone, the marls of which might in several parishes, particularly Dungiven, be applied to great advantage on the more sandy detritus of the carboniferous strata.

The map will show the curious manner in which the strata of the old red are intersected by greenstone dykes, many of which are closely related to the similar rocks of the basaltic field. The effect produced by some of them on the adjacent strata is very striking, and in all respects similar to that noticed and described as occurring in the vicinity of Lady O'Cahan's Bridge. The adjacent beds assume a parallelism, by cleavage, to the faces of the dykes, and become rudely prismatic, or rather break into small angular fragments. This is beautifully seen at the points of contact with the dyke in Fermanagh, parish of Derryvullan, and again at that near Clogher: but the subject will be again resumed in the next chapter.

In addition to the localities of porphyry already mentioned, laminar felspathic rocks have been since discovered, associated with the strata of the lower section of the old red sandstone, in Donacavey parish, townland of Carryglass, being a further extension westward of these remarkable rocks. And, in Clogherny parish, near Lough Patrick, the sandstones alternate with schistose beds, strongly resembling the silurian, but without fossils.

The faults and dislocations of the old red sandstone along the line of disturbance or elevation, at the base of Slieve Gallion, are represented Pl. C., fig. 20.

CHAPTER XI.

IGNEOUS AND METAMORPHIC ROCKS.

ALTHOUGH the study of fossil zoology, invested with the charms of a romantic novelty, and attended by results of the highest practical value, has attracted and maintained possession of the attention of geologists, it may be doubtful whether, as a subject of philosophical contemplation, it surpasses in interest the study of the phenomena connected with igneous and metamorphic rocks.

These rocks are here classed together, not because it can be affirmed that all rocks which resemble, in their ordinary characters, either trachytes, basalts, greenstones, or granites, have undergone igneous action, or, on the other hand, that all granites and greenstones have been sedimentary rocks, and brought to their present condition by metamorphic action, but because there is a connection so intimate between them, that it is often impossible to determine whether a rock has originally been a fused and intruded mass, or has acquired a new form of structure, and been assimilated to the crystalline and igneous rocks by the operation of metamorphic causes, the true nature of which is as yet unknown. Basalts and lavas, ancient and modern, are undoubted examples of liquefied, or even-flowing stoney masses, and serve, therefore, as types of comparison with greenstones and felspar porphyries; but no direct illustration of the origin of granite has hitherto been acquired from the observations of recent phenomena. The effects produced by its contact with sedimentary strata and the ramification of its veins into their substance have been cited as direct proofs of the liquefied condition of granite. Of these the results of contact resemble those produced by trap rocks, whilst granite veins are strongly contrasted with trap dykes. Dykes are in due relation to the peculiar semi-fluid condition of lavas, and traverse the strata in nearly direct lines; but veins, if really intruded veins, would imply perfect fusion and fluidity; they are in fact more analogous to the veins of quartz, which ramify in all directions through some mica schists, and also through many metamorphic schists. The condition and phenomena of granite have been also explained on the principle of long continued igneous action under great pressure, but in these respects it is not singular, as the matter of many trap dykes and of greenstones was probably subjected to an equal amount of pressure.

Without, however, attempting to solve so difficult a problem as the original condition of granite, it is worthy of remark that both granite and greenstone are connected with sedimentary deposits, each through a series of stratified rocks peculiar to itself; granite through the various forms of gneiss, mica schist, and clay-slate; greenstone through the hornblendic schists: both series of schists occurring blended together in one group, just as the granites and greenstones are also blended together, as will be seen in this chapter. Examples of granitoid mica schists and of numerous varieties of hornblendic schists have been mentioned in Chapter VII., and in the subsequent stages of metamorphic change there is an equal variety, and a remarkable blending of granitoid and greenstone rocks. The opinions of some of the most eminent foreign writers on the nature of such metamorphic changes have been quoted in Chapter I.; and it is certain that the theory of metamorphosis, itself a corollary from the theory of Hutton, has been gaining ground in England since its more recent promulgation by Mr. Lyell, and is a valuable aid in explaining many geological phenomena. As illustrative of the theory there is perhaps no one region so rich in varied facts as the district now to be described; in part, indeed, it is peculiarly fortunate, as it exhibits the results of almost every possible form of igneous action. On the Carn summit of Slieve Gallion is a cap of basalt and amygdaloid, or of erupted igneous matter, still resting on the chalk, whilst at its base are small but remarkable trap dykes. On the flanks and on the higher summit of Gallion are hornblendic rocks, some of which in their laminar cleavage, mode of weathering, and the occasional presence of carbonate of lime still indicate their former condition as stratified schists, whilst others are more crystalline, and resemble the more perfect greenstones; they frequently contain imbedded crystals of hornblende, which is a characteristic feature in metamorphic changes. But of all the rocks of Gallion, the most interesting are the granites and sienites, since they are so arranged as to place in the clearest light one of the most interesting phenomena of metamorphosis, namely, the passage of the marly sandstones of the old red sandstone, through various gradations, into a red sienitic granite. The intermediate state of the rock, between these extremes, has been noticed by preceding writers as a porphyry, but its true nature or that of the change it had undergone seems to have been entirely overlooked. Before proceeding further, then, it seems desirable to dwell for a few moments on this part of the subject, as being illustrative of the more general one.

In the preceding chapters some of the effects produced by trap dykes on the strata through which they pass have been noticed: they are of two kinds,—a physical one, manifested in new forms of cleavage, in a lamination conformed to the faces of the dyke, and in a general induration of substance; and a chemical one, exhibited in a new arrangement of some of its constituents; so that the mass assumes a character which assimilates it to the igneous rock. Such effects are doubtless aided by the quantity of water mixed up with all sedimentary deposits; but when the extent over which this action has extended is compared with the magnitude of the dykes, it is almost evident that the heat was not the only operating cause. Pressure, the long continued action of the slowly passing away heat, and, probably in dykes, electric currents, were combined in producing the effects observed. I am not aware that, as yet, the proportional distance, in respect to the magnitude of the dyke, to which such changes may be traced, has been investigated, and it is seldom practicable to determine it; the larger the dyke, however, the more its effects should correspond in magnitude with those produced by massive igneous rocks, though small dykes, when in contact with similar substances, should produce results of the same kind. The difficulty of drawing a definite line of separation between the modifying and modified rocks may also be sometimes illustrated by comparison with true trap rocks, whether in dykes or overlying masses; for example, it has been shown in speaking of the basalt, that the solid or normal rock is rarely found in contact with the underlying rock, a thin layer of a much altered character separating them, the result of a reciprocal action between the two; and in this manner, in passing from the unchanged rock and entering on a metamorphic region, it is sometimes impossible to stop at any fixed point within it as the commencement of an original igneous rock, the mutual action on, and assimilation to, each other obliterating the lines of separation. In the present locality two illustrations of the action of larger masses may be found in that of smaller, and will be here cited.

In Reuben's Glen, parish of Desertmartin, a small dyke of dense, fine grained, and highly crystalline basaltiform greenstone occurs, associated with the sandstones, which are here marly and felspathic, generally of a red colour, soft, and very slightly micaceous, passing, in the lower beds, into lighter coloured, more siliceous, and granular sandstones, with thin coatings of mica (white and silvery) on the laminæ. Adjoining the greenstone, though the actual contact is concealed by detritus, these sandstones present some very remarkable variations from their normal character. The marly beds are considerably indurated; their fracture, though still retaining a rude parallelism to the lamination, has become very uneven and rough, and the colour of the mass, which before was nearly homogeneous, now appears formed by a mixture of intimately blended particles of two distinct shades, whitish and red, rendering the general tint of the mass lighter; while disseminated through it are numerous spots of a darker colour, brownish, or purplish red. Where the rock has been exposed, these spots lose their colour and become white. Occasionally these spots are of a larger size, and then present evidences of crystallization, and appear to be felspar. In other parts the rock has become much indurated, and appears to be siliceous, with small distinctly crystalline portions of pinkish or rose-red felspar imbedded, forming a distinct porphyry, which has occasionally much the character of compact felspar; while in other portions the crystals of felspar are wanting, and the rock is hard, homogeneous, siliceous, or siliceo-felspathic; and these varieties may all be observed within the space of a few feet. The more gritty beds have become of a deep brown colour, with numerous small semi-crystalline particles of a white mineral, apparently felspar, disseminated. This portion of the grit has, from its dark rusty colour, and tendency to wear in spherical concretionary lumps and break in angular or prismatic fragments, so simulated some of the forms of basalt, that it requires a blow of the hammer to satisfy the mind that it is actually a sandstone. Sheet 46. Boundary of Cranny and Gortanewry. Nos. 72, 73, 74, &c.

Another very instructive and interesting example occurs in the same district, near Moneymore. A dyke of greenstone, three feet three inches wide, passes nearly vertically (the inclination being 70° to the north) through the sandstones, which are of similar character to those described above; they are thin bedded, and consist of a succession of gritty and fine grained sandstone beds, and layers of deep red and variegated green marl or coarse shale. These red marls, which at the distance of a few feet from the edge of the dyke are smooth in fracture and perfectly laminated in structure, a little nearer to the igneous rock have, in a great degree, lost this lamination, and have become quite nodular, and even imperfectly conchoidal in fracture, still, however, retaining their former red and variegated colour; closer, however, to the walls of the dyke they begin to change their colour, and assume a darker hue, till in contact with the greenstone they have become totally different in appearance and character; the red portions have become black, very much indurated, and have a glistening lustre, probably from imperfect crystallization,—their fracture conchoidal; while the green portions, which in their unaltered state are more sandy and micaceous than the mass of the bed, are changed in colour into a brown or brownish-grey, and are spotted; the mica has, in a great degree, disappeared, and is only seen on a favorable fracture. Notwithstanding these remarkable changes, however, the beds still retain, though rudely, their lamination. The sandstone beds, which at a little distance from the dyke, are of a bright red colour, granular, pebbly, and loosely coherent, with very little cementing matter, nearer to the igneous rock have assumed a greyer tint, and are slightly variegated in colour from incipient segregation of the ingredients; while close to the trap they are of a deep brown or reddish-brown colour, with a purplish tint, and have disseminated numerous small white particles (? felspar), their colour contrasting very markedly with the deep tint of the rock. The coherence of the sandstone is only very slightly increased by these changes, while the larger imbedded quartz pebbles have undergone no alteration whatever. The dyke itself also presents several interesting points for consideration.

As before stated, its total width is three feet three inches, and this at first appears to consist of three distinct portions; the centre part forming a wall-like division between the sides. It is a hard, dense, felspathic, crystalline greenstone, very slightly amygdaloidal, from occasional small cavities coated with zeolites. It is crossed by numerous divisional planes at right angles to the walls of the dyke, which separate it into cubical or prismatic masses; while the side portions, though also crossed by planes in the same direction, are separated by still more numerous divisions at right angles to the former, into flakes or laminæ parallel to the walls of the dyke; these divisional planes increasing in number as they approach the sides. This difference in the arrangement and frequency of the divisional planes is also accompanied by a difference in the apparent constitution of the rock itself, which is probably only the result of the re-action of the stratified rock on it. For while the centre is hard, dense, and crystalline, the outer portions next the sandstones are of a soft, clayey, and amygdaloidal character, very numerous small mineral nodules being imbedded in a light coloured, soft, felspathic, and clayey base; a difference which may be also due, in part, to the more rapid decomposition of these portions, owing to the easy access afforded by the numerous divisions, and their arrangement, to percolating water. This variation in character and apparent composition decreases on approaching the centre of the dyke, the two varieties passing almost insensibly into each other. In this example, therefore, the minor and incipient changes in the sandstones and marls are traced for some distance beyond the point where the mutual action between the dyke and the mineral matter it passed through was sufficiently strong to alter the physical and chemical characters of both, and so create an uncertainty as to the exact limits of each. See Pl. C., fig. 22.

The remarkable effects produced on the stratified deposits of this district by the protrusion of igneous rocks, even in such small and limited masses, lead naturally to the consideration of the interesting modifications which occur in connection with the sienitic rocks throughout the more extended range of Slieve Gallion. These modifications are very similar to the changes described; and their occurrence on a limited scale, when their origin and cause are obvious and undoubted, adds much to the probability that they are due to a similar, though not so apparent, cause on the larger scale. The sandstones are here, in general, highly felspathic, of a red colour, and marly, occasionally pebbly or finely conglomeritic. In tracing them up towards the granite rocks, the first alteration observed is a considerable degree of induration; the marls have, in some degree, lost their lamination, and the sandstones are altered in colour, having small white or greenish-white spots distributed through the rock : the rocks then become more sharply granular, and the spots, which were before only marked by the difference of colour, now assume a sub-crystalline structure, while numerous small crystalline fascets appear through the rock : a little farther on the lighter spots have become distinctly crystalline, and form little aggregations of a soft talc, or micaceous talc, generally of a peculiar light oil-green colour, occasionally grass-green, and passing into bottle-green; while the paste, now become crystalline, is of a dark red, frequently mahogany-red, felspar. The imbedded pebbles of quartz still remain unaltered in form, but appear traversed by numerous fractures and cracks. The rocks finally pass into a distinctly crystalline compound of red and abundant felspar, quartz, and greenish talc, or talcose mica. Hornblende occasionally appears in small quantity. The thin laminæ of the talc, though in such small quantities, are in many cases arranged in a divergent or plumose form.

The passage of these rocks, from well marked sandstones into crystalline rocks, may be examined in almost any of the glens along the eastern face of Slieve Gallion, and in one instance a portion of modified sandstone has been left resting on a distinctly crystalline rock. Thus on the boundary of the parishes of Lissan and Desertlyn, Sheet 46, Nos. 262, 261, 260, 259. In Carndaisy Glen, Nos. 188 to 194, and 180 to 184; at Quilly, Nos. 199 to 202; in Quilly Glen, Nos. 140 to 145; at Gortanewry, Nos. 109 to 112, and 88 to 90; at Cranny, Nos. 93 to 102.

A very interesting circumstance in connection with these is the repetition of rocks in every respect of a similar character, at a considerable distance from them, and much within the line of the lower granitiform rocks. Thus they occur above Carndaisy Hill, on the boundary of the parishes of Desertlyn and Desertmartin, Nos. 171 to 174; again on the boundary of Lissan and Desertlyn, Nos. 206 to 209; at Derryganard, Nos. 252 to 254; and at several intermediate places, though not exhibiting such gradations as at those mentioned, a circumstance which seems to imply that this upper portion of altered sandstone has been lifted up beyond its original position, unless it corresponds to the new red sandstone which underlies the chalk at the Carn of Slieve Gallion. In either case, the highly inclined beds of the old red sandstone, on the one side, stretching from the base of Slieve Gallion Carn, and dipping northward or from the disturbing mass, unmodified by metamorphic action, but internally disturbed and dislocated, and finally capped by the isolated patch of the newer secondary strata and basalt; and on the other, metamorphic and igneous rocks rising to the higher peaks of Slieve Gallion, seem to mark out the very focus and direction of the great changes and disturbances which have manifestly been here effected. The frequent occurrence of veins of sulphate of barytes in these rocks (as at Cranny, No. 93: Leitrim, No. 6; Quilly, No. 197,) is also a fact of much interest when taken in connection with the occurrence of similar veins in the older conglomerates of Ballynascreen and Maghera, in immediate connection with the mica schist, and in those of Tyrone, as at Clogher, where it is abundant in immediate proximity to the great dyke in that neighbourhood; and near Ballygawley where it occurs in similar conglomerates close to the metamorphic porphyry rocks, as well as in that porphyry; and again near Barrack Mountain, parish of Pomeroy, and elsewhere. These veins are numerous, and of large size; the barytes is, for the most part, massive, and of the common pinkish or reddish-white colour; occasionally crystallizations occur.

The dip also of the sandstones, which in the upper beds seldom exceeds 20° at most, near the crystalline rocks is increased to 40°, or even 60°.

The example which has been cited from Slieve Gallion, of the transition of a mineral mass, by whatever agency effected, from the ordinary form of a sedimentary deposit to the condition of a highly crystalline rock, is not merely interesting in itself, but valuable as an explanatory illustration of the phenomena of other localities. The stream which passes by the village of Orritor runs through a deep detritic ravine, the sides of which are encumbered with large irregular blocks of hornblendic rocks, and were once clothed with a natural wood, of which a few stunted trees and shrubs still remain. At the bottom of the ravine, in the townland of Gortin, the sandstone appears in the river; it is yellowish, and occasionally associated with red and mottled clays. Ascending the stream, it becomes conglomeritic; pebbles of white and grey quartz being abundant, and of mica schist small and rare. Here, on approaching a greenstone rock, symptoms of metamorphic change appear: the earthy sandstone is indurated, and breaks in angular or prismatic fragments, whilst the passage is further indicated by the development of red specks in a darker paste. A portion of the altered rock externally resembles the ochres of the basalt, and, when wet, stains the fingers; another is much like petrosilex; whilst the resulting mass is semi-crystalline, with crystals of red felspar. It may be doubted whether any portion of the rocks here seen is entirely free from the effects of metamorphic action, and, taken together, they are another instructive example of such changes. Close to the village of Orritor, on the road to Cookstown, is a small mass of similar character, exhibiting the angular fracture, red ochreous cleavage, imperfect development of crystals of red felspar, and finally a hornblendic rock, syenitic, from the red felspar. Two other patches of this metamorphic syenite occur in the parish of Lissan west, or left of the road from Cookstown to Lissan Mill, some portions of which exhibit only an incipient crystallization, their angular and ochreous red cleavage at once marking their origin: and there is here, also, much rubble of an apparently decomposed granitic rock. The locality on the Kildress River is one of more difficulty. Immediately above the Bridge of Kildress, and continued in the beds, which appear five hundred yards below it, are red fossiliferous grits, associated with conglomerates, which must be considered either the summit of the old red, or the base of the carboniferous strata, and have evidently been thrown up by a spur from the great underlying mass of igneous and metamorphic rocks. The sandstone strata are, therefore, present, and in close connection with the massive rocks. Three hundred yards above the bridge, or one hundred and fifty above the grits, and in such a position that, if prolonged according to the cleavage, it would pass under them, is a considerable mass of red granite, which is divisible by numerous cleavages into small red angular fragments. A portion of the sandstone above the bridge, or nearest to the crystalline rocks, has nearly lost its granular structure, and is principally a mass of hard vitrified quartz, speckled with oxide of iron, and abounding with the casts of smooth Pectens, probably Pecten ellipticus and Pecten hemisphericus. The granite is highly crystalline, composed of flesh-coloured felspar, which forms about three-fourths of the entire compound; quartz and dark green chloritic mica, and occasionally minute crystals of hornblende, and small masses of semi-crystalline granular epidote; whilst the adjacent hornblendic rock is a highly crystalline syenite, of which hornblende forms probably four-fifths of the compound, the quartz and felspar being only in small quantity. In portions of this, the course of metamorphic change is still visible, as veins of a felspathic and finely granular granite pass through it.

At first sight, the granite, where compared with the smaller portion which occurs 300 yards higher up the river, has somewhat of the appearance of a dyke, and even seems to separate some minor portions of the adjacent greenstone from the larger mass; but a close examination will, I believe, prove this an illusory appearance, the greenstone being irregularly mixed up with the granite at the contact, and even separating the more western patch from the rest. The greenstone itself, near the junction, exhibits characters of transition, crystals of red felspar assimilating it to the granite, a circumstance which may be noticed in almost all the localities, and respecting which it is right to observe that, in such changes as those which have been here described, it must not be supposed that the passage is necessarily effected by the gradual transmutation of one rock to another in a manner so insensible that no lines of demarcation can be drawn. Such, certainly, appears the case on the large scale, when it is seldom possible to note the exact termination of one, and the commencement of another variety; but when the point of such change can be noted, it will be often found marked by a definite line of separation, and specially by a variation in physical characters: for example, the more perfectly formed derivative granite cleaves into rectangular, and the indurated semi-crystalline rock into rudely angular or prismatic fragments. This abrupt change, which sometimes produces the appearance of dykes, is consistent with reason, and may be illustrated by the chemical doctrine of definite proportions, the rock, on arriving at a certain point in the metamorphic change, being so altered in its conditions as to assume a new and definite form. West of Pomeroy, on the road to Omagh, at Cavanakeeran, and at Tremogue, near the cross roads to Altmore, are the indurated grey and red grits, and in the narrow and steep ravines, which open into the deep glen, extending with its little river to Tremogue Bridge, and there opening into the more expanded glen below, granite and hornblendic rocks again appear. For a moment, the physical features of this interesting spot may arrest attention; the easily destructible nature of the sandstone has facilitated wear, and produced a rounded or moulded form on the bluffs, which is very striking and beautiful. Occasionally these bluffs have been undermined and cut down, when there appear, as it were, steep gashes in the detritic banks. Below the Altmore cross road, before mentioned, two streams, winding round an elevated bluff, meet, and their commingled waters meander through the green, delicious, and expanded vale, which terminates at Athenry. The sides of the valley, though here and there broken by a descending stream, are swelling and graceful, whilst a detritic knoll appears below, and is scarped abruptly to the river. It is impossible to look at this scene without feeling that it is a miniature model of the snow-smoothed sides of the Alps, as they are represented by Agassiz. The rivers enter and their streams join just as do the stony currents of the Moraines; the resemblance, however, is one only of form, but it adds the zest of an imaginary to the real beauties of the spot. Ascending on the higher ground, it is equally remarkable; it appears a general flat, divided into valleys by ridges of gravel, which stand out from the flat, and, when softened down by time, and smoothed by cultivation, contrast strongly in their vivid green with the dark surrounding bog. Occasionally they become escar-like ridges, on one of which the mountain road runs towards Lough Lily, the escar, which before had run in a north-east direction, narrowing and curving gradually round to the west, as it approaches the lake and more mountainous ground: but it is perhaps impossible to bring home to the mind these appearances. There are here no elevated mountains to send down their glacier currents freighted with detritus: the gravel itself is principally local, or sandstone, although mixed with many pebbles of the harder hornblendic rocks, and occasionally bearing on its surface large angular lumps of the same description. Various causes have, without doubt, been in action, both together and in succession, forming the gravel, distributing and arranging it, sometimes confusedly, and sometimes in successive beds of fine and coarse materials, and then again wearing it away and moulding it into all its present forms. Floods, currents, floating ice, and glaciers are all required to account for the varied appearances of detritic matter in different localities.

Returning to the granite, at the lower locality, a quarter of a mile above Tremogue Bridge, it appears in a narrow and steep lateral ravine, still retaining a rude lamination with a southern inclination, and an opposite cleavage: some portions are so fine in grain as to seem a mere crystalline grit, though very hard and close in texture, and fragments of sandstone are abundant in the detritus. The hornblendic rocks appear on the steep faces of the glen, and higher up are in the bed of the stream. At this point, then, there does not appear any difficulty in understanding the phenomena as connected with metamorphic agency.

The second or eastern of the Tremogue localities is one of much greater difficulty, the granite being so peculiarly associated with the hornblendic rocks as to render their actual relations to each other a question of much obscurity. In the steep ravine which here enters the greater glen, the granite occupies the lower portion, whilst the hornblendic rocks rise up at the sides in more elevated masses, and the effect is, therefore, as if the granite had passed between these masses; but, on examination, the granite is observed to extend along the face of the larger glen, or to skirt on that side also the hornblendic rocks, and if only seen there, it would be at least equally probable, that it abutted against the greater mass of the latter rising up behind it. The difficulty, however, does not cease here; for whilst, on one side of the opening of the ravine, the granite is more than usually massive, on the opposite it is remarkably fissile, being cleaved into small rectangular fragments, and there it exhibits the appearances of a dyke. The rock, which is thus, as it were, intersected by the granite, is not, however, a greenstone in its normal condition; it is dark, smooth, close-grained, and has externally, from its unctuous and glossy fracture, the aspect of an indurated serpentine, contrasting strongly with the granite by its colour, and also by its mode of fracture, which is irregularly angular or pyramidal, instead of rectangular. On one, the west, side of the granite, the line of separation between the two rocks is strongly marked, the granite looking like a red wall supporting the dark mass which rests against it: on the other it is obscured. The actual relation of this rock to the hornblendic rocks, as regards its position, cannot be determined, nor can it be safely said that it is more nearly connected with them than with the granite; so that it must be doubtful whether it is an earlier or a later product of metamorphosis. The stratified rocks occur on the opposite side of the great glen; they are sandstones of a dark, dusky red, or purplish colour, sharply granular in structure, calcareous, slightly micaceous, and much indurated. The granite is fine grained, felspathic, rose-coloured (No. 73), with the same peculiar dark green talcose mica noticed before. The greenstone is close grained, laminar in structure, with thin coatings of carbonate of lime on the fissures (No. 74). This passes into a more largely crystalline compound of hornblende and felspar, with small irregular strings and masses of epidote. Veins of a soft, decomposed, highly felspathic character, with traces of serpentine, pass through the rock (No. 75). The rocks are precisely similar (Nos. 78, 80), and again in the glen in Athenry demesne (Sheet 36, Nos. 5, 6), where the granite is, as before, highly felspathic and rose-coloured, but is more largely crystalline; and lepidolite, of a silvery tint, in small scales, is an occasional ingredient. Near this, at Hazel Hill, is a very beautifully crystalline diallage rock, with concretionary veins of hypersthene, which will be again noticed.

The same phenomena are observable on the western edge of the hornblendic rocks, where, north of the Termon rock, in the bed of the river which crosses the Omagh road, red earthy sandstones and red granites again appear. The sandstone at the lower locality near the road has been raised, as it appears to bend over a ledge or spur, probably of the metamorphic rock; the granite is loosely aggregated, and contains abundance of pyrites in small cubic crystals. More westward again, in the parish of Termonmaguirk, a large mass of granite has been developed within the limits of the sandstones, possessing the curious calcareous character which is so remarkable in the singular rock of Lime Hill, parish of Pomeroy. The other localities of granite marked on the map cannot be so distinctly brought into connection with the co-existence of secondary strata; but it is by no means improbable that such have existed, and the granite may not without reason be used as a guide to determine their former extension. In this district, therefore, the granite appears to skirt the great mass of altered schists and hornblendic rocks of various descriptions, being accompanied in its course by an exterior band of secondary strata, chiefly of the old red sandstone. The actual relations of these rocks to each other it is, of course, impossible to demonstrate with positive certainty, or the nature of the action which has been reciprocally exercised one upon the other; yet it is easy to recognise several peculiar forms of structure which seem to attend upon this metamorphosing process. The peculiar red and sometimes calcareous granite—the fissile, decomposing, and unctuous greenstones—the syenitic greenstones, in which red felspar, corresponding to that of the granite, is extensively developed—all appear connected with these changes; but it must still remain an obscure question, what was the real agent, or what the original rock, which served as the immediate or proximate cause of change. In no instance within the range of these inquiries has the granite been found in visible contact with unchanged sandstones, and in some cases, as in Tremogue Glen, there is a strong natural line of separation; yet when the circumstance of their co-existence along so extended a line and the nature of the phenomena are fully considered, it seems impossible to doubt that they have had a mutual effect on each other.

Cotta, in his examination of a somewhat similar connection between the granites and syenites and the quader-sandstein of Meissen, Hohnstein, Zittau, and Liebenau appears to have experienced similar difficulties in understanding their mutual relations, more particularly as the granite is there found in some localities to overlie the secondary sedimentary deposits, a case which has not occurred in the present district, and it may not be without advantage to quote his closing remarks. (Wanderungen, Part II., pp. 52, 53.) "That the granite, in these examples, has undergone a change of place, vertically from below upwards, since the deposition of the quader-sandstein, cannot well be now doubted, though it may be yet asked in what condition it was so raised? The examination of the appearances along the boundary proves to the reader as well as the observer, that it must have been in a solid, not a fluid state, as no veins or ramifications of the granite into the sandstone are ever to be found, nor fragments of the latter in the former, nor fusion or other signs of heat; on the contrary, near Hohnstein, large and small fragments of granite are found in the nearest conglomerate, whilst south of the boundary line the same sandstone is undisturbed. The agency by which granite and syenite have, along this remarkable boundary line, raised up and here and there forced away the original sedimentary deposits, whilst everything to the south of the line remains quietly in its primary state, must ever remain unknown to us." The moving or exciting cause must indeed remain unknown, but the coexistence of granitic and syenitic rocks, the many varieties of rock by which they seem blended together, the direct connection of some of these varieties with the sedimentary deposits; all show that, in their present condition, they are the result of causes acting subsequent to the deposition of the old red sandstone.

In whatever light, then, the granite be viewed, whether as itself a derivative rock, or as an original igneous rock, its peculiar characters, combined with its position in respect to the secondary sandstones on the one hand, and the pseudo-greenstones on the other, and the intermediate forms of passage exhibited between them, leave no doubt that there has been a powerful action and reaction, tending to modify the characters of all, and to produce results which, under different conditions, would also have been different; and if this be true, it is not improbable that, though now removed, the secondary strata were once in contact with the granitic rocks of the Murnells, and some of the other localities, which on the map appear separated from them. The actual causes of the phenomena must still remain uncertain; yet, as it has been seen that, by the operation of dykes, a certain amount of such changes has been produced, if the presence of such dykes be taken as an evidence of the existence of large masses of a similar rock below the surface, it may be readily supposed that their action would extend over large spaces, and in its results be modified by the peculiar combinations of the various rocks in contact with it. This, indeed, is shown by the granitiform rocks of Bardahessiagh and Craigballyharky, which differ considerably, in general characters, from the granites noticed in the several patches along the line of junction. They rise into lumpy knolls, forming the two summits of Bardahessiagh (721 and 710 feet), and Craigballyharky (771 feet), and are also associated with rocks of a greenstone character. Quartz is here a much more abundant ingredient, occurring in lumps of some size, which, from their rounded outline and fractured, though not crystalline character, give the rocks a peculiar and somewhat mechanical aspect—(Nos. 45, 48, Sheet 45). The quartz occurs both whitish and greenish, while the felspar is either red and crystalline (Nos. 45, 46, 47,) or whitish and only granular: in all cases the mica or talc is dark green, earthy, and chloritic, while the hornblende (locally abundant) is deep blackish-green, and in distinct crystals (No. 49). A remarkable character occasionally results from the mode in which the ingredients occur in segregated patches promiscuously arranged (No. 48). These rocks are also frequently marked by the occurrence of numerous lumps of bluish milky quartz, which occur imbedded in the mass (Sheet 38, Nos. 68, 67, 66, 58, 54, 73). The occurrence of lumps of similar bluish quartz has been already noticed in the previous report on the geology of Templemore, where they occur in the gneissose schist, and, in arrangement, preserve a rude parallelism to the laminæ of the rocks.—(See Ordnance Survey of Londonderry, page 4.) Lamination certainly does not exist in the rocks at present under description; but there is a certain amount of fissility, if it may be called so, or a tendency to break, with flattish surfaces, a circumstance which will be further noticed in the description of the hornblendic rocks. Thus, though at Bardahessiagh, these rocks, in mineral character, approach very nearly to the syenitic granite previously described, in many respects they differ much, and present, on the whole, a semi-mechanical aspect. Intimately asociated with these granitiform rocks are the hornblendic or greenstone-like rocks of the same district (see map and section, Pl. G., fig. 2); and though the relations between them cannot, as stated before, be satisfactorily made out, still the occurrence of granitic veins in the hornblendic rocks appears to afford a proof that the granite, at least, in its present state, is the result of a cause continuing to act subsequently to the formation of the hornblendic rocks. The large mass of altered schists, assuming a hornblendic type, but still betraying their former condition in their mode of arrangement, which occupies the larger portion of the metamorphic area, will be further noticed; but passing from its boundary into the great sandstone district, new proofs will be obtained of the extended action of basaltiform rocks, both by the presence of dykes and by the co-existence with them of porphyritic rocks, corresponding to the felspar porphyries of Antrim, which appear to have been produced under very similar circumstances.

Included within this great extent of sandstones and conglomerates, three detached areas are shown on the map, distinguished by a peculiar marking here used to denote a porphyritic structure. They are in the parishes of Pomeroy and Donaghmore, (Sheets 45 and 53. County Tyrone), and in the parish of Errigal Keerogue, near Ballygawley (Sheet 52). In Pomeroy, the most northerly of the three forms the summit of Shane Barnard's Sentry Box (901 feet), Cappagh Mountain (865 feet), and Barrack Mountain (865 feet), while the adjoining portion stretches south, with an irregular outline, extending to the boundary of Killeeshil and Donaghmore. In physical feature, as compared with the adjoining sandstone district, these porphyritic rocks differ considerably, presenting a more irregular and sharply broken outline, and rising into sudden knolls, or forming tabular caps, strongly resembling those of basaltic districts, which contrast with the long slopes and wavy character of the adjoining district; differences, no doubt, arising from the superior hardness and consequent indestructibility of these rocks.

Previously to describing the rocks which occur within these areas, it will be necessary briefly to notice the trap dykes which are met in the immediate neighbourhood, and their connection with the stratified deposits through which they have been injected. By a reference to the map, it will be observed that these trap rocks are seen at five several points on Sheet 45, preserving throughout a sensible parallelism of direction, and exhibiting a marked similarity in mineral character.

The trap is first seen about a mile north-west of Gortavoy Bridge (see map), passing, in a vein eighteen inches thick, through the conglomerates and sandstones which immediately overlie the fossiliferous silurian schists. The dyke is of dense basaltiform greenstone; its joints thinly coated with carbonate of lime, which also occurs occasionally imbedded in small amygdaloidal cavities (Sheet 45. Nos. 90, 91). Similar trap again shows itself, in two veins, in Cornamaddy, about a mile west of the former, possessing the same mineral character of crystalline basaltic greenstone, of the same thickness (18 inches), and traversing rocks of the same character (Nos. 80, 81, 49). Another dyke occurs north of Carroll's Bridge (see map), identical in mineral character, but here accompanied by amygdaloid, and being three feet in thickness. It is veined with carbonate of lime. These dykes or veins occur in the sandstones, but on the north side of Cappagh Mountain (No. 205), greenstone of a similar character, and in part highly amygdaloidal, occurs in a small stream, abutting against the laminated porphyritic rocks. Again, a little west of this, it appears denser, and itself slightly porphyritic in character, and in parts becoming so nearly homogeneous in texture, as to approach in aspect to some varieties of pitchstone (No. 16). This latter variety is traversed by thin strings of a hard granular and flinty mineral, of a dark-red colour, and having much the character of Thomson's chalilite. Close to this, the sandstones, which are thin bedded, of a deep purplish colour, fine grained, slightly micaceous, and very felspathic, possess a very high degree of induration, and are traversed by veins of carbonate of lime (Nos. 11, 15). Similar greenstone is again seen on the boundary of Aghnaskea and Sessiadonaghy (No. 190), and on road-side (No, 143), identical in mineral character, being a crystalline felspathic and slightly amygdaloidal greenstone; in both cases associated with the porphyritic rocks.

The protrusions of undoubtedly igneous rocks, which occur in this neighbourhood, having been thus briefly noticed, it remains to examine more in detail the remarkable varieties within the district under consideration. The character and composition of the sandstones of the district has been before stated, and the fact noticed, that the slaty sandstones or flagstones are usually the upper, and the coarser and more conglomeritic beds the lower strata, a position analogous to that occupied by the laminar and porphyritic felspathic rocks. As a whole, they may be described as compact felspar, frequently porphyritic, and occasionally slightly amygdaloidal; for the most part laminated, seldom calcareous, though sometimes containing small calcareous nodules, dense, and in many cases much impregnated with iron. But, though this is their general character, several modifications occur, which will be here noticed. A hard semi-granular compact felspar paste, of a purplish-brown or deep olive-brown colour, with numerous imbedded crystals of felspar, of a greenish tint; and small cavities, with a greenish powdery matter, apparently resulting from the decomposition or imperfect formation of similar crystals; in structure it is unevenly laminated. This forms the Sentry Box (No. 1): a little to the south the rock is similarly laminated in structure, the basis more granular, and marked by small segregated patches of felspar, of a reddish tint; they are not crystalline, and apparently differ little from the paste in which they are imbedded. The crystals less distinct and numerous, (No. 2). In another variety, the paste is lighter in colour, but still of the same compact granular character; the rock very vesicular, the cavities are lined with green earth, and, from their number and minuteness, give a very speckled appearance to the mass (No. 3). Again (at No. 11) there is a laminar compact felspar, very slightly porphyritic, but vesicular and amygdaloidal, the vesicles being lined or filled with carbonate of lime, green earth, and in some cases coated with calcedony; carbonate of lime also coats the joints (Nos. 11, 13, 15, 18, 19). The calcedony frequently stretches out into interrupted strings, and the cavities, in general, have an arrangement somewhat in layers, corresponding with the laminæ of the rock. This in the lower portion is much more dense, has large crystals of reddish felspar imbedded, and is also speckled with minute crystals, which appear to be hornblende, and the small cavities are filled with red jaspery agate. The paste is occasionally green, and in parts has much the aspect of hornstone; fracture uneven, and rudely conchoidal. In immediate connection with this, a thick layer of impure sandy limestone occurs in the sandstones, (No. 11 a). Similar compact laminar felspar rocks of the same dark reddish-brown colour, and with the same imbedded crystals of felspar, and cavities lined with green earth, &c., occur at Nos. 206, 207, 110, 111: at Nos. 29, 30, 31, where the crystals of hornblende are distinct, and at 32, 33, in the glen between Cappagh and Barrack Mountains: again forming the summit of Barrack Mountain (Nos. 36, 40, 41, 42, hornblende in crystals), (43, 44, 45, 62, 61) very dense and compact, and having small crystals of hornblende imbedded besides the felspar, and in all cases presenting the laminar structure noticed before. To the south of Barrack Mountain, the rocks are traversed by strings and nodules of red jasper and porcelain jasper, with white calcedony and granular quartz (No. 35); also with thick veins (14 inches thick) of carbonate of lime, much discoloured by iron. In the neighbourhood of these veins, the rocks are of a peculiar emerald-green colour, are uneven or nodular in fracture, and slightly vesicular. Within this area of the porphyries, is met a rock of very peculiar character. It is composed of numerous angular fragments, similar to the adjoining porphyries imbedded in a very hard, and apparently siliceous paste. These fragments vary in size, from the twentieth of an inch to an inch in diameter, and are exclusively of the varieties of porphyry which occur in the neighbourhood. This mass is hard and close-grained, the fracture going across both paste and imbedded lumps, though not equally (No. 112).

The other irregular area of the porphyritic rocks presents very nearly the same varieties as those noticed above. In the townland of Glenbeg, a short distance north of the road from Donaghmore to Athenry, a small patch of nearly similar rock is seen. It is a compact felspar of a reddish-brown colour, with semi-crystalline patches of flesh-red felspar, which appear to have a somewhat stringy arrangement. These give the rock a spotted appearance, and it approximates very closely in character to those varieties presenting the same appearance, which have been already described in connection with the Slieve Gallion rocks. Adjoining it, a vein of barytes, four inches thick, occurs in the sandstones, which are here sharply granular, very felspathic, thin bedded, and slightly micaceous (No. 104). The greenstone dyke, which occurs in Aghnaskea (No. 193), close to the road from Donaghmore to Athenry (see map), has been already noticed (page 524); and in connection with it is observed the same peculiar alteration in the sandstones which was before described. They are very felspathic, arenaceous and pebbly (No. 196), becoming highly indurated (No. 195), and are in contact with the same peculiar compact laminar felspar porphyry (No. 194). This porphyry is here also traversed by thin strings of the same red porcelain-like jasper, and is vesicular, the cavities being filled with green earth, &c. (Nos. 194, 193); and attention may be also directed to the similar veins, strings, and nodules of jasper, which occur in the altered porphyritic rock of Cushendall, in Antrim, from which such beautiful specimens are produced; in fact, that whole district will be found to afford much illustration in the several points which have been here noticed. In immediate contact with the greenstone, the rock is of a light copper green; in constitution, it does not appear to differ much from the adjoining rocks; there are, however, but few crystals of felspar imbedded, while small lumps of quartz occasionally occur. It is irregularly marked with some darker matter in ill-defined patches, is in parts calcareous (Nos. 181, 189); and is traversed by veins of crystallized carbonate of lime, with red serpentine (No. 189 a). At a little distance, the rocks are of the same character, and dark brownish colour, as noticed before (No. 188). At the eastern extremity, again, of this porphyritic area, where the stream which bounds Crosscavanagh and Dernanaught divides them from the sandstones, they are found to present similar varieties. In parts, they must be described as marked by segregated spots rather than distinct crystals; the more compact variety, where unweathered, is distinctly porphyritic, occasionally slightly tufaceous, and even slightly amygdaloidal (Nos. 68, 69, 66). The cavities in others appear to be the result of the decomposition of crystals, probably of felspar, which fall into a light whitish-green powder, and round them a small ring of the matrix is of a lighter colour (No. 135). Similar rocks are again seen in a stream a little north of the boundary of Donaghmore and Pomeroy (Sheet 45, Nos. 139, 140, 142), associated with dark purplish, flaky, and slightly micaceous sandstones. The porphyritic rocks are in part calcareous, and have thin coatings of carbonate of lime on the fissures. The outline of these porphyries, as exposed, here curves with an irregular bend towards the west (see map), when, near the junction of Sheets 45 and 53, we find them again in contact with conglomerates and sandstones, dark coloured, micaceous, and thin bedded, and in the lower beds with conglomerates of the same peculiar character as those of the great area, within which these porphyries are included. At the junction, veins of barytes, with carbonate of lime, pass through the rock (Nos. 145, 144). The joints also are coated with calcareous seams. Here, on the road side, is the small trap dyke noticed before (page 524, No. 143), and the adjoining rocks have also the same calcareous seams (199), and the small cavities are occasionally filled with carbonate of lime.

Similar laminated compact felspar porphyry occurs near the edge of Sheets 45 and 53 (Nos. 153, 154, 155); here also slightly calcareous, and in parts, from the numerous small imbedded crystalline portions of carbonate of lime ,having a very amygdaloidal character (No. 153). Occasionally the rock is more siliceous, of a lighter colour, and is more impregnated with iron (No. 155). From this point the same rocks extend southwards to the boundary of Donaghmore and Killeeshil (Sheet 53), still exhibiting a peculiarly laminated and slightly vesicular character (Nos. 53, 55).

The third patch of these rocks, as before mentioned, occurs in Errigal Keerogue parish, a short distance north of Ballygawley, near the outskirts of the great area of the old red sandstones. They appear in several points within a limited extent of an oval form. They offer no varieties distinct from those noticed before, the rocks being essentially, compact felspar of a brownish or purplish-grey colour, with numerous small cavities coated or filled with green earth, and with occasional imbedded crystals of felspar; they are rudely laminated, the cross fracture being rough, and imperfectly conchoidal (No. 9). Again, they are darker, and more purplish in colour, the imbedded crystals are more numerous, and there are traces of small crystals of hornblende; the paste is slightly more crystalline (No. 43). This varies, becoming much more cavernous, the cavities, for the most part, being empty, excepting a thin coating of green earth; the rock itself of a redder colour, the paste more granular, and the crystals of felspar more numerous, varying much in size. Where exposed, these crystals lose their colour in part, and thus become more distinct; in general they differ in colour little, if at all, from the including paste, and are only distinguished by their crystalline structure (No. 47). Small portions of crystallized carbonate of lime occur in the cavities, associated with green earth; occasionally the lamination, which is usually so prevalent, disappears (No. 48). Veins of barytes occur in rocks of very similar, though somewhat more mechanical character, which occur associated with the conglomerates (No. 45). The other points, where these porphyries are seen, within this area, afford no remarkable varieties (Nos. 15, 16, 18), carbonate of lime filling numerous cavities in the rock, which thus assumes an amygdaloidal character, as before noticed. There is also a very limited development of porphyritic rock within the sandstones on the boundary of Clogherny and Cappagh parishes, near Lisboy Bridge (Sheet 35), near which a trap dyke is also seen, though the sandstones immediately adjoining it are not perceptibly affected by the contiguity. In Sheet 57, a little north of the county boundary, another limited development of porphyritic rocks, in connection with trap dykes, is likewise observed.

In considering the remarkable rocks which have now been passed under review, it has been seen that two very distinct forms of modification can be traced in connection with secondary strata of the same age and mineral character. The marly or earthy beds of the sandstone have been observed to pass into crystalline rocks of a syenitic type on the one hand, and on the other to be replaced by peculiar felspathic porphyries, which, from their position and superficial extent, have every appearance of an arrangement conformable to that of the sandstones. What, then, is the cause of this difference? a question which can only be answered by a recapitulation of the conditions observable in each case. In the one, the altered or metamorphosed secondary rocks are arranged along the border of a great schistose district, in which similar metamorphic changes are everywhere apparent, and are accompanied throughout by rocks of a granitic type; in the other, the porphyries occur in the midst of the sandstone district, and are in immediate contact with basaltiform rocks, and subject to their direct action alone. Still, however, there is this difficulty, that the simple action of basaltic dykes on similar strata has, in other cases, produced a result more corresponding to the syenites than to the porphyries; and it may, therefore, be reasonably conjectured that the matter of which the porphyries are composed has in part been derived from volcanic eruptions, either of mud or dust, and subsequently exposed, with the other strata, to metamorphic action. The presence of basaltic dykes indicates that causes very similar to those noticed in the great basaltic district were here also in action; and the appearance within that district of porphyritic rocks so similar to those here described is another strong reason for believing an equal analogy to have existed in their mode of formation. It has indeed been suggested that the felspathic porphyries of Antrim were the ochres which had been subjected to metamorphic or igneous action; but this is extremely improbable, as there is little analogy between the composition of the ochres and the porphyries, although there is an analogy between them and some of the more recent lavas; and in the present case a still further proof is afforded of the true origin of the Antrim porphyries, and of the epoch of their formation, in the appearance of such similar beds connected with the secondary sandstones of Tyrone. The two districts, therefore, illustrate each other with respect to the porphyries, just as they have been seen to do in the syenites; a remarkable proof that such phenomena are due to definite causes, or to the operation of definite laws, though it may not always be in the power of the geologist to discover their mode of acting.

The position of a portion of the granite is such, that it seems certain it must have either existed prior to the sandstones, or at least have been removed from their reaction, and there appears even to be a difference of structure and composition corresponding to this difference of origin or epoch; whilst the occurrence of pebbles of a similar rock, in the conglomerates connected with the Fermanagh silurian schists, tends further to prove that it had existed prior to that epoch, and, consequently, that some of the metamorphic changes visible in these districts were long anterior in date to others. In like manner, the occurrence of pebbles of porphyry in the conglomerates which appear to underlie other masses of that rock, proves that all the porphyry beds are not of the same date, but that they alternate with the sandstones and conglomerates. It is only necessary to add that, in some of these porphyries, vertical cleavages have produced a highly laminated structure; but in no instance has a distinct prismatic character been here observed, though it is strikingly exhibited in some of the porphyries of Antrim.

Returning to the great mass of altered schists which occupy so large a portion of the metamorphic area, and are skirted or succeeded, on their eastern and southern border, by the rocks which have been already described, the peculiarity of its position cannot fail to attract attention. Succeeding to the mica schist, and preserving a kind of parallelism to its ordinary strike, this band of rocks, partaking more or less of a hornblendic type, but graduating, by so many minute shades of difference, from rocks which, if seen in small specimens, might still be almost deemed schistose, into those of a highly crystalline structure, that their former condition and the transition they have undergone cannot be deemed doubtful, extends through the parishes of Lissan, Kildress, Desertcreat, Lower Bodoney, Termonmaguirk, and Cappagh, or from the north face of Slieve Gallion, in Derry, to within four miles of Omagh, in Tyrone, a distance of about 24 miles, whilst in some parts of its course it is six miles broad, the whole therefore occupying a space of great extent, and affording a very curious example of the persistence, under similar circumstances, of a peculiar mineral type.

Within this great tract of metamorphic schists, the local peculiarities of which will be subsequently detailed, a ridge of micaceous schists rises up to assist, as it were, in explaining their origin. These schists are gneissose, and, from the predominance of the cleavages over the lines of stratification, have evidently undergone a certain amount of metamorphic action. The ridge is elevated and bold to the north, where it includes the Fir Mountain (1188 feet), Ballynasollus (1261 feet), and Beleevnamore (1253 feet), but it narrows and sinks to the south-west. It may be considered to extend beyond Lough Fea, on the north-east, to Corick, though in a somewhat more modified state, and thus to form the north-west flank of Slieve Gallion, the distance from this point to its south-west termination, in the parish of Termonmaguirk, being about 12 miles. The character of the country is remarkably and characteristically dependent on its mineral condition. The gneissose schists rise into peaks, and, combined with the vast mounds of detritus which, even at that elevation, skirt the western flank of Slieve Gallion, give to the vicinity of Lough Fea a mountain grandeur; whilst the metamorphic schists, which emerge in small detached crags from the marshy bog, seem to finish out the peculiar dark and dreary wildness of the adjacent flat. It is difficult to describe intelligibly such scenes; but to those acquainted with the mountain road from Cookstown to Ballynascreen, the dreary and yet interesting aspect of that portion of it which passes over the county boundary must be familiar. It has the appearance of an elevated plain, encircled by mountain or by hill, and black with bog which even in summer is a morass, and is only broken by isolated crags of the metamorphic schists, or studded with large, apparently detached, fragments. Here, too, however unpromising the bog in itself may seem, cultivation has appeared on its edges, and every gravel hill or ridge sufficiently extensive, is becoming tenanted by the farmer.

These appearances are dwelt on because they assist us in understanding the relations and conditions of the rocks themselves; the rough crags which peep out, as it were, from the bog, though isolated, preserve a certain degree of parallelism, and are evidently portions of ridges, or beds, corresponding in direction to those of the ordinary mica schists; and in a similar manner the huge detached lumps, which cannot be stated as in sitû, affect a similar arrangement; some of these lumps are of large size, one north of March Hill being 21 feet by 15 by 6. In this wild district, and in the parish of Ballynascreen, several remarkable beds of iron quartz are met with; they form low basseting ridges, having a direction from E.N.E. to W.S.W., are nearly even with the bog, on the sloping or northern side, but raised in a low cliff on the south, the extent visible being about 60 yards; they correspond, therefore, to the usual arrangement of the mica schist, and further support the theory of the metamorphic nature of the hornblendic schists. The quartz is massive, has an angular or wedge-like fracture, and is so imbued with iron, that, on weathering, it assumes a red tint, with spots of a deeper hue; it is penetrated by numerous intersecting veins of white quartz, varying in thickness from an inch to a mere film, many of them accompanied by thin sheets of micaceous iron, usually, or perhaps always placed between two films of quartz. The veins containing the iron do not appear to possess any definite direction. These beds are only local, the principal metamorphic masses being here, as throughout the district, a fine-grained schistose hornblendic rock, speckled with minute crystals of iron pyrites; but it is worthy of remark, that another bed of the same jaspery quartz, with micaceous iron, accompanied by the same rocks, occurs in the parish of Kildress, in the townland of Beaghbeg, and a similar quartz, though without the iron, in Termonmaguirk. The Kildress bed is fifteen feet wide, and can be traced on the surface for sixty yards; its direction is more nearly east and west than in the preceding example, a direction which appears to conform to that of the prevailing cleavage of the altered schists. Allowing, therefore, for those variations in the strike or lateral contortions so common in the unaltered schists, the continuity of these remarkable beds is at least not improbable; and as their present condition cannot be considered original, they afford another example of the persistence of cause and effect, under the same mineral conditions, through a very extensive district. At the Beaghbeg locality, the altered schists exhibit several marked varieties, all, however, indicative of change; some are true hornblende schists, and very laminar, splitting into thin layers; whilst the schists in general, at this point, are very siliceous, and penetrated by quartz veins. South of the iron quartz the rocks are also much varied, and thin layers of a rock, like hornstone, appear mixed up with the other varieties. This combination can be traced on the surface for about fifty yards, the cleavages being nearly vertical, and in a direction from east-north-east to west-south-west, in which direction, also, the bed is very schistose—all, therefore, conforming to the ordinary arrangement of the mica schist. The manner in which the hornstone-like layers are associated with the other schists is rather obscure; but in one spot they appear to separate the common form of altered schists from a more greenstone-like variety, which is again succeeded by the common species; and a union so intimate, combined with such marked differences, seems inexplicable on any other principles than either variety of original substance, or an elective separation of the elements into distinct beds under the influence of the metamorphic agencies, and is similar to that noticed in the mica schists.

The physical features of the whole of this tract are so remarkably uniform as to become almost characteristic; the same upland flats, with their brown covering of bog, broken here and there by ridges or rocky crags, prevail throughout, and in the northern portion are further modified by narrow ridges, or escars, of gravel. The country extending from Orritor towards the road from Cookstown to Lissan, possesses these characters in a very remarkable degree, and is a singularly wild and rugged district, in fact, a mere plain of rocks; and it is within a region so distinctly marked out as one of metamorphic change, that the mica schists rise into the elevated and nearly continuous range which has been noticed. In general direction, it corresponds with the schist ranges of Derry, which pass into Tyrone, to the north-west of it, skirting the northern boundary of the hornblendic rocks, and continues to exhibit the same mineral characters as have been before noticed (page 199), in Sheets 39, 40, 44, of Derry. These schists are in general talcose, occasionally dark-coloured, earthy, and siliceous (Sheet 20, Tyrone, No. 19), green, siliceous, and calcareous (No. 20), or very talcose, the quartz being in irregular layers (Nos. 21, 25). The dark-coloured and earthy variety is also found highly indurated and cherty, and resembling much some of the indurated shales of more recent geological eras, which occur so frequently in connection with igneous rocks (No. 23). Others are gneissose and quartzose, and resemble the more common state of the Derry schists (No. 26), while in the talcose variety small lumps of quartz occur imbedded, giving it a peculiar character. Still following the range of these rocks, the same mineral character prevails, talcose quartzy slate, frequently of a gneissose character, being the ordinary form (Nos. 11, 12, 13, Sheet 19), passing into fine talc-slate, with common garnets imbedded of some size (Nos. 29, 30, 33, 34), or becoming more hornblendic and somewhat fibrous in structure (No. 10). Thin calcareous veins pass through them, while in the more common variety quartz veins are abundant, occasionally accompanied by chlorite (No. 24), and pyrites is likewise not uncommon, occurring in considerable quantity as loosely-coherent and granular lumps imbedded in the hollows of a very cavernous quartz vein (No. 27). In the direction of their strike, which, as a reference to the map will show, preserves a considerable degree of regularity, it might naturally be expected that throughout the range there should be but little variation in lithological character, and accordingly schists are found, identical in structure and composition with those described, extending across the north-west corner of Sheet 27, in the direction of Omagh.

At the boundary of Lower Bodoney and Cappagh parishes (Sheet 27), about a mile north-east from Mountfield, a small detached patch of the old red sandstone intervenes between the schists and the metamorphic rocks, while the precise limits of either are concealed by accumulated detritus.

The schist rocks now pass by Lough-a-Tirrive to within about a mile and a half north of Omagh, where, at Killyclogher, the old red sandstone again rests on them, agreeing in mineral character with the isolated portion near Mountfield. From this, their outline proceeds nearly due north, through Mountjoy forest, Erganagh glebe, and Rosnamuck. Along this line they are immediately succeeded by sandstones and shales of the carboniferous series which contain Modiola *Macadami,* and a small Posidonomya, corresponding to P. *complanata,* &c., and are thus identified with the deposit on the White Water in Ballynascreen (County Derry), already referred to. North-east of this the schist rocks form a very elevated ridge, containing Slieveard (1381), and Mullagh Carn (1778). The same mineral character is preserved throughout, talcose quartzy slates being the prevailing variety, while finer talc-slates, with garnets, are not uncommon.

Returning from the great or regular range of the mica schist to the detached ridge, its rocks present, as a whole, the same general aspect, though they are more crystalline, and have, in many cases, lost much of their mechanical character. Their north-eastern boundary, where they adjoin the granitic rock, is not well defined. On Sheet 46 of Derry is found a small patch of the schists entangled, as it were, among the granitiform rocks into which they graduate; and on the boundary of the counties the character of the rock is of such an indefinite kind as to render it doubtful to which class they should be referred. In every primitive country, varieties are thus met with, the true relations of which are by no means at first evident, and which, considered by themselves, would unquestionably be referred to that class to which, in mineral character, they are most nearly assimilated, although on a more extended examination they would prove to be only varieties, extremely local in extent and variable in character. This difficulty, common to all extended primary districts, is not wanting in that at present under consideration, as schistose rocks are here observed on the one hand to graduate into hornblendic rocks, which finally assume a very distinct greenstone character, and on the other to pass, by equally varied gradations, into the granites; and there is, therefore, no small difficulty in drawing a distinct line of division, founded on sufficiently marked characters. Near Lissan, the stream, which forms the boundary of the counties, passes over gneissose rocks, rudely schistose in structure, the laminæ being marked by plates of scaly mica, while the ingredients are all crystalline, and, where the rocks are more massive, they become granitic (Sheet 29, Tyrone, Nos. 52, 53, 54, 55). Veins of a rose-coloured felspathic and slightly hornblendic granite, similar to that which has been so frequently noticed before in detached patches in Tyrone, pass through these rocks (Sheet 45, Derry, No. 93), the ingredients in the veins being sometimes largely crystalline and distinct. A light-green talcose matter frequently occurs disseminated, or coats the fissures; and coarse granular epidote also occurs, with carbonate of lime, in small quantity. The schistose rocks of Fir Mountain dip to the north-east and east; they consist of dark-coloured micaceous gneiss and schist, the colour being derived from the prevalence of black mica and the occasional presence of hornblende; layers or laminæ of reddish felspathic and syenitic granite are of frequent occurrence (Sheet 21, Tyrone, Nos. 11, 12, 16); and there are besides, large detached patches of similar syenite or of felspar alone, imbedded in the mass, while occasional layers of talcose clayey slate form partings (Nos. 15, 17, 25, 9), though the rocks, while retaining this schistose structure, are on the whole massive, and form with the Fir Mountain a distinct ridge. At Killycurragh, and extending thence east and south towards Cookstown, are similar rocks; having the same general dark colour from prevalence of black mica, the same layers, veins, and patches of syenite (Nos. 96, 100, 102, Sheet 29), and the same partings of soft talcose matter. They possess throughout a higher degree of induration, breaking into irregular masses, and having, in a considerable degree, lost their schistose character. In the adjoining hills of Beleevnamore and Ballynasollus (Sheet 20), they again present the same mineral character and arrangement; they are here even more granitic in structure, the schistose arrangement of the ingredients being seen only on a favorable fracture (Nos. 2, 4, 6). The laminæ also are much contorted, and curved in the more earthy and micaceous layers (No. 8). Passing into Sheet 28, the same character and composition can still be traced in the schist rocks. In Evishbrack (1085 feet), and the adjoining hill, Beltonanean (1043), there are the same semi-crystalline rocks (Nos. 2, 3, 5, 8), the same layers and patches of syenitic aspect (Nos. 4, 6), and the same more clayey layers (Nos. 4, 8). At Evishbrack summit, in the gneissose rocks, are numerous crystalline patches of epidote (No. 5), while in the adjoining townland of Corvanaghan distinct crystals of hornblende are found imbedded in the rocks, which thus constitute a variety intermediate between the ordinary one and the more hornblendic rocks yet to be described.

A marked depression here occurs in the range of the schists, through which the Kildress River, in its upper course, flows, and where the rocks are concealed by the accumulated detritus which covers the sides of the hills. They again crop out in Killeenan Hill, near the southern edge of Sheet 28, and still retain their crystalline and gneissose character, the same felspathic granite layers, &c. (Nos. 31, 32, 34), the same black metallic mica, occasionally forming layers in the rock (No. 34), and in many parts the same evanescence of the schistose structure. On the boundary of the parishes of Kildress and Termonmaguirk they present the same mineral characters (Nos. 30, 29, 28, 53, 54, 55, 56, Carnan Hill), and here, along the line of junction between the schistose rocks and those which have been marked as metamorphic, are found rocks peculiar in aspect, and interesting as affording a clue to the origin of many of those of Slieve Gallion and of other localities, the relations of which are exceedingly doubtful. They are semi-crystalline, rudely porphyritic, and somewhat conglomeritic in aspect; the general paste of the rock is granular and felspathic, either of a greenish or reddish-brown tint, imbedded in which are many fragmentary and much fractured lumps of quartz, generally vitreous, often milky, with crystalline portions, and some few distinct crystals of opaque, white or greenish, and semi-translucent felspar; also crystalline plates of dark green earthy mica. These rocks (Nos. 27, 26, 22,) have a very marked and peculiar look from the contrast in the colour and character of the ingredients. Similar varieties occur in connection with the granitic and hornblendic rocks of Slieve Gallion.

The rocks are now concealed by detritus for some space. A little west of Cregganconroe (Sheet 37, see map,) they again appear, associated with the hornblendic rocks, but the relations of the two varieties are very obscure. In mineral character, the schists are granitic and gneissose, confusedly and coarsely crystalline, quartzose, and slightly hornblendic (Nos. 67, 66), and correspond in aspect to those already noticed as occurring in connection with the hornblendic rocks of the more northern ridge; nor is it without interest that they are thus observed as on either side they approached the more distinctly metamorphic rocks, to have assumed a similar mineral character. A small detached patch of these rocks occurs to the west, in Sheet 36, No. 13; its actual connection with the adjoining district is not seen, but the general character of the surface and the arrangement of the detritus render it most probable that the schist rocks are continuous up to their junction with the old red sandstones, as represented on the map.

This portion of schists has been thus passed in detailed review, as one which, from its remarkable position, might be expected to exhibit traces of those modifying agencies which have so evidently acted on the hornblendic schists by which it is bounded; and both in the mineral conditions of the rocks, and the alteration of their structure as to lamination and cleavage, this expectation has been fully realized. The resulting tendency has here been to pass into a granitic form, and to afford, therefore, an illustration of the occurrence of that species of rock in conformable position amidst the great mass of the Derry schists, in which metamorphic action could be only assumed as analogically probable, just as the hornblendic rocks, similarly associated with the schists, illustrate the great and apparently independent development of such rocks which have now to be noticed.

On the map, it may be seen that, between the detached range of the schists, which has been described, and the regular schist district of the north of Tyrone and Derry, there is a broad belt or zone of rocks, which is coloured emerald green, as indicative of their altered or metamorphic condition. In connection with the mica schists of Derry, numerous beds of hornblendic rocks have been noticed, and were also considered metamorphic; they have, however, in no instance, so large or regular a development, and are in all cases confined more to local and detached points, whilst there is here a continuous range of rocks of a similar character. Rising in the summit of Slieve Gallion to a height of 1730 feet (the highest point in this district), they project from thence in a tongue-like form towards the east, underlying the detached outlier of Slieve Gallion Carn, and the small area of the old red sandstone which occurs near it (See Plate E., figs. 3, 4, 5). Westwards, they stretch in a southerly direction, forming a tolerably regular band, which occupies a horizontal space about two miles broad. On the south-east is another, but not continuous range of hornblendic rocks, rudely parallel to the preceding one, and stretching from near Lissan, past Orritor, south of Kildress Church; then again appearing, in a detached area, near the silurian schists (see map and section, Pl. G., fig. 2), and still farther to the south-west, forming a tract of some extent near Athenry.

These rocks have been already briefly noticed at several points on their south-eastern border, but it still remains to examine them in detail; in doing this, the more northern zone will be first considered, and, commencing at the Slieve Gallion district, they will be traced southwards, as has been done with the other rocks. The remarkable modifications which some of the mica schists of the southern portion of Derry have undergone have been mentioned, as well as the occurrence of distinct crystals of hornblende in the talcose slates of Ballynascreen parish; but it may be well briefly to recapitulate the circumstances. At a short distance from the overlying sandstones, the schists are of the ordinary somewhat gneissose character, passing downwards into talcose and hornblendic slates, occasionally fibrous or asbestiform in structure; quartz, as an ingredient, is abundant in all, and forms the larger portion of the mass; the other ingredients are sometimes wanting, and a siliceous schist is the result: the talcose laminæ are usually of a light green colour, or dark green, with high pearly-metallic lustre, having the aspect of mica, but the softness and peculiar saponaceous feel of talc. Tracing these beds downwards, they first appear indurated and curved; and on proceeding farther, the following changes, which are probably best seen, within a limited space, in ascending the bed of the White Water, may be observed. Near the sandstone and shale beds, a quartzose talc-slate is seen, both the ingredients of which are of a greenish colour; the talc layers are irregularly marked with darker patches of a deep bottle-green tint; the laminæ curved and irregular (Sheet 40, No. 33). Thin seams of white crystalline carbonate of lime traverse the rock. To this succeeds a bed differing only in the relative proportion of the ingredients, quartz being more abundant, while the talcose matter is more collected into detached patches. Similar beds succeed, differing slightly in the ingredients or their proportion; small pebbles of glassy quartz occasionally occurring imbedded in the general basis, and the rocks being frequently gneissose. The felspar in others is more abundant, is reddish in colour, granular, and mixed with the other ingredients, which still retain a rude lamination (Nos. 34, 35.) Beds of granular whitish quartz occur here, thickly studded with small perfectly formed crystals of iron pyrites, while the talc still forms thin divisions irregularly arranged. Similar beds are repeated in descending lower in the series, varying slightly, some being more siliceous, others more felspathic, till at about half a mile from the commencement of the schists, the rock contains, imbedded, numerous well developed and distinct crystals of hornblende (Nos. 181, 182, 44). These crystals are arranged in a truly crystalline manner, crossing the laminæ of the schists in every direction, though in the majority a tendency to an arrangement of the prismatic planes parallel to the lamination may be traced. Similar rocks occur to the west of this (Nos. 176, 177, 169), in the bed of the stream which passes downwards near the old church of Ballynascreen.

Turning to the east of Slieve Gallion Carn, the small stream which descends towards Desertmartin cuts through a thick deposit of sand and gravel, and exposes in its bed a series of very similar rocks, the junction of which with the overlying sandstones is concealed by an accumulation of clayey gravel. The sandstones have been already described, and the great disturbances to which they have been subjected noticed; their lowermost beds are traversed by numerous veins of carbonate of lime. A little higher up is met a green-coloured quartz rock, very dense, and spotted with numerous specks of oxide of iron (No. 122). Small portions of felspar occur, and thin quartz veins (No. 123). The quartz still prevailing, the felspar increases in quantity, and small crystals of hornblende are seen, which give the rock the peculiar character of an ill-marked syenite (No. 124). To this succeed beds of talcose quartz-slate, very ferruginous (No. 125), and alternating with them is a rock, the general paste of which is siliceous and granular, with numerous small crystals of hornblende imbedded (No. 126); it is distinctly slaty in structure. Passing downwards, are found highly ferruginous quartz-slates (No. 127), and green talcose quartz-slates of the same character as those before noticed (Nos. 128, 129). To these succeeds a dark green siliceous rock, very hard, and with numerous small crystals of hornblende, and minute portions of calcareous matter imbedded (No. 130). Similar quartzose slaty rocks succeed, with thin coatings of carbonate of lime on the cleavages (Nos. 132, 133), and then dense quartzose and felspathic rocks, very ferruginous, with thin seams of carbonate of lime, and thick veins of barytes, much coloured with iron (Nos. 134, 135). Near this is a close-grained serpentinous rock, with thin strings, and imbedded crystalline portions of carbonate of lime (No. 136), and with somewhat of a porphyritic character, from numerous small semi-crystalline portions of felspar imbedded. Pyrites is disseminated in small crystals, and the rocks have, in part, a peculiar aspect from many lumps of whitish felspar, which strongly contrast with the general green colour of the rock (No. 136, 2); and associated with them are hard talcose quartz-slates, with thin seams of barytes (Nos. 138, 27).

Passing to the eastern extremity of the tongue-like projection of these rocks, where they again come into contact with the sandstones, the occurrence of thick veins of sulphate of barytes, associated with irony quartz, has been mentioned, and in a pebbly or conglomeritic rock (No. 93), accompanied by greenish quartz rock similar to that described above, and passing upwards into the ordinary sandstones. A little up the hill from this point is met, at Tirgan rock, a dark green very fine grained quartzose rock; minute crystalline fascets of a dark colour (? hornblende) are seen, and thin strings of carbonate of lime traverse the mass (No. 150). It is nearly laminar in structure. Accompanying it is a semi-crystalline granular, calcareous, greenstone-like rock. Under a magnifier distinct crystals of hornblende can be traced, though to the eye the rock appears nearly homogeneous; filiform seams of serpentine pass through it, and pyrites occurs in crystals; the fracture is uneven, and it breaks rudely into flaky pieces (No. 149): it projects in knolls or lumps on the side of the hill. A little north of this, and close to the line which has been marked as the probable boundary of the sandstones, is found a very hard, green, flaky quartz rock (No. 82), with a quartzose felspathic rock, having many small imperfectly formed crystals of hornblende (Nos. 82, 153), a variety of which has been before alluded to as forming an ill-marked syenite. Resting on this is a bed, which, from its peculiar conglomeritic and arenaceous character, should most probably be referred to the overlying secondary rocks or sandstones, and which, therefore, forms a passage between the two. Proceeding up the hill, rocks are found on several points, agreeing precisely in mineral character with those already described. They are either hard, dense, and nearly pure quartz rock, rudely schistose (Nos. 155, 159), semi-crystalline, with crystals of hornblende imbedded, and seams of serpentine (Nos. 154, 160), or still more crystallized, and having a distinct greenstone character, with thin veins or fissure-coatings of carbonate of lime (No. 157). Veins of syenite (reddish and felspathic) occur in several places (Nos. 156, 158), and the rocks themselves become porphyritic from imbedded (? segregated) crystals of felspar (No. 162, Windy Castle).

These rocks, from their resistance to decomposition, as compared with the granitiform rocks, form a slight escarpment around the hill (see Plate E., fig. 5); and the several streams which carry off the drainage of the hill having, as it were, eaten into them, have produced the undulating outline, which is represented as far as the scale of the map would admit. The summit of Windy Castle (Plate E., fig. 4,) presents varieties similar to those already described (Nos. 163, 164, 165), which also extend for a short distance down the stream which forms the boundary of the parish of Desertlyn and Desertmartin, accompanied by veins of quartzy ironstone (No. 167), and frequently by calcareous veins.

Again in the adjoining stream which marks the boundary of Lissan and Desertlyn parishes, and forming a projection between the two streams, the rocks are more chloritic, with minute seams of epidote traversing them (Nos. 214, 213, 212); granitic veins, with included fragments of the rocks, occur here. The summit of Tintagh is dense, close-grained, finely granular, green, and siliceous; a few occasional crystals of felspar imbedded, and portions of carbonate of lime filling small cavities. Veins of granitic character penetrate the rock, composed of vitreous quartz and greenish granular felspar, with distinct crystals of reddish felspar imbedded (Nos. 219, 220). Siliceous ironstone or very ferruginous quartz, similar to that before noticed, occurs at several points (Nos. 224, 222); being here also near the junction of these rocks with the granitiform varieties, and associated with rocks of the same ill-marked syenitic character (Nos. 225, 227) as were mentioned in connection with the schistose rocks of Ballynascreen, and with the greenish (? chloritic) quartzose rocks. These are all rudely schistose in structure, and are traversed by numerous planes of cleavage; in some, small crystals of hornblende occur imbedded in a greenish felspathic paste (No. 229). The summit of Slieve Gallion is composed of similar dark green quartzose rock, with small portions of carbonate of lime imbedded. The same varieties continue to the edge of Sheet 45, hornblende becoming more prevalent in the portions near the granitic rocks, and in general aspect they resemble much the variety noticed before as forming Tirgan rock (Nos. 236, 239, 240, 241, 250, 251, &c). The rocks of the western slope of Slieve Gallion, between the summit and Lough Fea, though agreeing in general character, appear either to have been subjected to a less amount of modification, or, from original composition, to have been less susceptible of change. The more distinctly hornblendic and greenstone-like rocks are absent, and those of a decidedly schistose type prevail. The same varieties are found to occur here which were noticed on the White Water; schistose quartz, greenish and talcose (No. 29, Sheet 45), with dark purplish clay-slates spotted with green, and having small patches of green talc imbedded (No. 28), beds of lighter colour, and very cherty in aspect (No. 36), and numerous intermediate states. The variety before described as an imperfectly defined syenite, is again met with here; it varies much in character, but the ordinary base is a dense and compact felspar, frequently with numerous thread-like seams of a green saponaceous matter (? serpentine), and having many lumps of vitreous quartz imbedded. The relative amount of the ingredients is subject to much variation, and the aspect of the mass necessarily varies; at one time assuming the character of a granite, which differs, however, essentially from the ordinary form of that rock, the felspar not being crystalline; and at another becoming a dense petro-siliceous rock, which appears to be composed entirely of an intimate admixture of felspar and siliceous matter. To the west of this sheet (45, Derry) the rocks can be traced graduating into the more ordinary forms of the schist, being quartzose and talcose, and similar to those which have been already described. Associated, however, and distinctly interstratified with these, is found a remarkable variety, which has been already noticed as occurring at several points near the junction of the stratified and metamorphic or crystalline rocks. It is invariably traversed by veins and patches of crystallized carbonate of lime, and by fissures and cleavages so numerous as to render it difficult to obtain a fracture showing the actual structure. These fissures are coated by a dark green, talcose, clayey matter, disposed in irregular flakes, and on exposure, become coated with oxide of iron. Viewed on a fresh fracture, the mass proves to be composed of finely crystalline hornblende? and quartz, the ingredients being arranged laminarly, while the seams of carbonate of lime cross the laminæ generally at right angles, but occasionally are disposed parallel to them. The rock is sometimes more massive and crystalline in structure, but in all cases is equally fissured, so that its actual composition can only be observed on a favorable fracture. The occurrence of this very well-marked variety among the undoubted schists of this district is deserving of particular attention in reference to the question, which it materially affects, of the origin of the more crystalline rocks.

Near the boundary of the counties, veins of micaceous iron, already alluded to, occur in considerable quantity in a dark, ferruginous, and occasionally jaspery quartz rock. The iron is arranged in wavy flakes, varying in thickness from the most filmy scale to about the twentieth of an inch. It is titaniferous. On a close examination, it is found that, interposed between these veins and the rock through which they pass, there is always a thin, sometimes scarcely perceptible, film of pure quartz (Sheet 45, No. 11). Similar veins will be again noticed, and, taken in connection with the iron quartz containing them, may be considered a modified condition, probably metamorphic, of the Eisenglimmerschiefer of German geologists, a species of the Glimmerschiefer family, remarkable for often containing leafy films of gold.

Still proceeding westward from Lough Fea into the County of Tyrone, the rocks preserve the same character; they appear on the side of the hill and in the plain below Fir Mountain, are hornblendic and crystalline, yet still schistose (No 5), a structure which is produced by thin irregular laminæ of quartz; and when these laminæ nearly disappear, the mass becomes more homogeneous, and sometimes chloritic (No. 4). Between these rocks and the well-marked schists, a semi-schistose rock (noticed at page 536), with large crystalline lumps of felspar of reddish colour imbedded, is seen (No. 7). Near the edge of the sheet, the rocks are more distinctly syenitic (Sheet 21, No. 3, Sheet 20, No. 9); veins (? concretionary) of largely crystalline hornblende and felspar pass through the rock (Sheet 21, No. 2). The schists appear in junction with these rocks. Close to the boundary of Lissan and Kildress parishes, dense dark green quartzose rocks appear (No. 10), and similar hornblendic syenite, finely crystalline, with veins of coarse, rudely crystalline granite, containing hornblende, passing through it (No. 11). A little farther west, the rocks have a distinct greenstone character, are very fine-grained, and slightly chloritic (No. 12), or beautifully crystalline (No. 13). Still farther west, at the southern edge of the sheet (No. 20), are similar very fine grained, dense, hornblendic rocks, schistose in structure, and traversed by veins both of largely crystalline hornblende and light-coloured felspar with traces of epidote, and of coarse-grained rudely crystalline granite with hornblende (Nos. 15, 16). Through the nearly homogeneous crystalline basis, small portions of light-coloured felspar are disseminated (No. 18), or the rock becomes more distinctly crystalline, and, from the occasional presence of quartz, passes into a syenite (at No. 17) and (at Nos. 28, 29) west of the Owenkillew River, and are more crystalline at the edge of Sheet 28. Between this point and Dungate rock, similar varieties occur, occasionally talcose and schistose (No. 15, Sheet 28), or highly indurated and siliceous, (Nos. 47, 45), accompanied by veins, or rather beds, of crystalline greenstone, slightly diallagic (No. 40), or slightly chloritic (No. 13). Jaspery iron quartz, with veins of micaceous iron similar to those previously noticed, is again found here. The quartz is cavernous, and the cavities are coated with rock crystal, in small, but very perfect crystals; pyrites, is abundant in small granular crystals (No. 14). The iron is here also titaniferous. Dungate rock is composed of a very siliceous, close grained, dense rock, of a green colour (No. 48), which is again seen at the boundary of Kildress and Termonmaguirk parishes, with pyrites disseminated (Nos. 17, 18, 19), and with veins of epidote, generally massive, and shooting into crystals in the cavities (No. 18). The rocks are here also somewhat amygdaloidal, from the numerous small cavities filled with carbonate of lime (similar to Slieve Gallion), a variety which may again be seen at Miveel rock (see map).

The remarkable varieties which occur between these metamorphic rocks and the schists to the south have been noticed, and the fact should not be overlooked, that rocks, corresponding to each of these varieties, are interstratified with the mica schists of Derry, in describing which they have been noticed.

Continuing in the course of these rocks to the south-west, the uniformity of their physical features is, as before observed, very remarkable, and it is impossible, as they project from the detritic surface, or from the bog, in detached knolls, to trace their continuity satisfactorily, or in a direct manner; and it is only by the comparison of specimens from distant points that any regularity of succession can be established. If, however, this plan be adopted, and the country be examined in sufficient detail, the almost endless varieties, which in each separate case appear intermixed in inextricable confusion, assume, under this extended comparison, the appearance of considerable regularity, and of a disposition of the rocks (even the more highly crystalline) in belts, rudely corresponding in direction to the strike of the more distinctly stratified schists, with which they are associated. To describe in detail the several varieties, is unnecessary, as they are identical with those already noticed; but if comparatively viewed in the above manner, some curious results are obtained. Thus, at Formil rock (Sheet 27), passing from the schists, a syenitic rock is first observed; it is imperfectly crystalline, being composed of hornblende, quartz, and felspar, with small portions of the same dark green earthy talc, so common in the district; pyrites in crystals, and many small crystalline particles of carbonate of lime disseminated (No. 43). It varies as the quartz or hornblende prevails; but from its confused and imperfect crystallization, combined with the partly remaining schistose structure, it has, in all cases, a peculiar aspect. To this succeed beds of siliceous slates, or slaty quartz rock, identical with those before described as occurring at Ballynascreen, in Derry (page 539), and ill-defined syenitic rocks (No. 34) also similar to those previously mentioned, and associated with the same green talcose quartz rock, with a schistose structure (No. 23). From the limited appearance of these rocks, their exact arrangement cannot be seen; but there is strong reason to believe that they are interbedded, just as in the precisely similar succession of rocks observed on the north face of Slieve Gallion, where there is distinct interstratification. But the point to which attention is more particularly at present directed, is the repetition of varieties precisely similar, and similarly arranged to the south-west; as, for example, at Cashel rock, a little west of Formil Bridge (Nos. 33, 34, 35, 36); also at the southern edge of this sheet (27), west of Lough Fingrean (Nos. 53, 54, 55); and again in Sheet 35, (Nos. 8, 9, &c.), near

Faccary Lodge where veins of quartz, with slight traces of copper, occur. As before stated, the detached and limited appearance of these rocks in separate knolls affords no means of actually tracing their arrangement; but the repetition of the same varieties in so marked a manner, and at points so distant, cannot fail to arrest the attention of any one who examines the district in detail. Mr. Griffith, in the last edition of the large geological map of Ireland (dated January 12, 1842), has removed the district now under description from the erupted greenstones, as which he had previously coloured it, to the metamorphic schists, but has still retained a patch of greenstone near Formil Bridge; the rocks are, however, identical in character throughout, and either the entire district or no part of it must be considered greenstone. At the particular locality represented as greenstone, the rocks have even less of an igneous aspect than many from the immediately adjoining district; as, for instance, those to the south-east, where the rocks are dense, close grained, siliceous, greenstone-like, and occasionally slightly porphyritic (No. 14), often approaching to an amygdaloidal character, having small cavities generally filled with carbonate of lime, which decomposes on exposure, and the mass then becomes cavernous. Veins are present of the same peculiar quartzose jasper (accompanied by a greenish-black cherty substance), which has been before noticed in connection with the micaceous iron of Dungate and Tullybrick. At Loughmacrory summit, between this point and Lough Fingrean, there is a knoll of rocks identical in mineral character with the variety already noticed in Ballynascreen, in which well-developed crystals of hornblende are imbedded in a siliceous and talcose basis, the rock in the large having a schistose arrangement (Sheet 36, No. 57); and the occurrence of this peculiar variety, so well marked in Ballynascreen as having been derived from the schists, but here enveloped in the more highly crystalline rocks, adds another to the many proofs of the derivative origin of the latter. Between this point and the rocks to the east, is found the semi-granitiform variety, in which compacted felspar forms the principal paste, having lumps of quartz and crystalline portions of felspar imbedded.

Rocks exhibiting the same modifications are continued through the range across Sheets 36 and 35, the old red sandstones and conglomerates east of Omagh, resting against them; while to the west, and included within the sandstones, occur two detached patches, in both cases calcareous, of the peculiar variety which has been before described as generally occurring near the boundary line of the stratified, and derivative or metamorphic rocks.

Proceeding to the more southerly range of the hornblende rocks, they are, in many respects, very similar, though, as a whole, much more crystalline and massive; and although, after having traced the successive development of similar varieties, distinctly intercalated with the more evidently derivative rocks of the northern belt, there can be little hesitation in assigning the same origin to these, they would not, if considered by themselves, afford the same satisfactory evidence of a derivative condition. A remarkable character, which appears to distinguish this range from the other, is the prevalence of hypersthenic rocks; but even that peculiarity is not exclusively its own, as it is sometimes, though rarely, observed in the more northerly.

The connection of these rocks and the granites with the sedimentary strata at several points has been already noticed. They are first seen towards the north, near Lissan, north-west of Cookstown. In Lissan River, beds of granitic schists occur, and close to the hornblendic rocks two detached patches of syenites have been noticed. The actual junction of the two forms of rock cannot be seen; but in immediate connection with the more northerly patch of syenite, are fine-grained, dense, hornblende rocks, with thin strings of quartz, and having pyrites disseminated (No. 112, Sheet 29); while close to the more southerly, the greenstone rocks are themselves syenitic, having reddish felspar in crystals; and near the adjoining stratified rocks, they are largely crystalline hornblende rocks, occasionally porphyritic, from large macled crystals of dark-coloured felspar imbedded (No. 20). This structure is, however, very local, as the rock in junction with it is very chloritic, rudely flaky, and calcareous (No. 21); and again, though still retaining the chloritic character, it becomes highly crystalline and slightly diallagic, and then passes nearly into the state in which it was first met (No. 23), but only to re-assume the more chloritic and flaky appearance (No. 24); all these variations taking place within a very short distance.

The principal mass of these rocks is found west of the road from Orritor to Lissan, where they form a series of separate hummocks, which are portions of transverse beds, though forming together a broken ridge. Most of them are diallagic (Nos. 109, 115, 117, 118, 119), with concretionary veins, or rather diffusing masses of largely crystalline hypersthene (Nos. 120, 121 A.), which at the latter place is associated with a very fine-grained, serpentinous, greenstone rock, and a quartzose and felspathic granite, with traces of hornblende (No. 121). Diallagic greenstone rocks again appear in Kildress River, near Wellbrook (Nos. 80, 79), and at Kildress church (No. 83), while adjoining them are fine-grained greenstones, similar to those before noticed. The diallage rocks occur in their most normal state at Athenry (Sheet 36), where they are a beautifully crystalline compound of light greyish-green diallage and greenish felspar, hornblende in minute quantity being also occasionally present (No. 4). In this are veins and segregated, or diffusing masses of hypersthene, varying in the size of its concretions from half an inch, or an inch, to the most minute crystals. It is of a dark colour and highly pseudo-metallic lustre. This diallage rock presents a well-marked instance of what has been already alluded to as a kind of fissility, arising from the arrangement of the prismatic planes of the crystals parallel to each other, and to the general plane of the rock, an arrangement which is not uncommon in hornblendic rocks, and has apparently arisen from the crystals having been formed under the influence of some common cause, such as polarity. The largely crystalline concretions of hypersthene occur more as masses than veins, suggesting the comparison of a liquefied mass, thrown, as it were, into a tenacious fluid of different composition, and diffusing itself with ramifications from a centre through it; while, on the other hand, the intimate admixture of the many varieties of the hornblendic rocks, sometimes passing into each other and at others disposed in such an irregular manner, into one continuous mass, suggests the idea of a partial and confused admixture of various tenacious fluids.

Many of the hornblendic rocks of this range, though not distinctly hypersthenic, contain small crystals of that mineral, which are exposed on the weathered surfaces; but in general they are either chloritic, or a somewhat confused crystalline mixture of felspar and hornblende, with traces of chlorite (No. 197), or largely crystalline hornblende rocks, the felspar being white or greenish-white, with traces of epidote (Nos. 85, 136, Sheet 29); or distinct syenites, occasionally porphyritic, from crystals of reddish felspar imbedded (No. 135) near Orritor, and above Kildress Bridge. The varieties which occur at Bardahessiagh, already noticed, differ little from those already described, though there is here no trace of hypersthene. At the Murnells, the rocks are either dense hornblende rock, in which hornblende forms nine-tenths of the mass (No. 58), or largely crystalline hornblendic syenites (No. 59). To the west of this, are very close grained greenstones, rudely laminar in fracture (No. 60). At Cregganconroe, the greenstones are crystalline, with traces of diallage, and with veins of a coarse quartzose syenite passing through them; while still farther west, at Creggandevesky, chloritic and confusedly crystalline rocks (No. 89), or syenitic greenstones, with strings of granular epidote (No. 90), appear. The greenstone rocks at Tremogue Glen, to the south of this sheet (37), have been already alluded to (page 518); they are either close-grained, dense, and apparently siliceous (No. 73), a variety which is distinctly laminated, or more crystalline greenstones (No. 71). At the more westerly glen, the rocks are similar; and their connection with the granitic rocks in both these places, as also at Athenry Glen, has been noticed. West of Athenry, at Termon rock, the slaty greenstone character prevails; the rocks are either very hornblendic (Nos. 8, 12), more siliceous, with pyrites (No. 9), or more largely crystalline; and at the north end of Termon town, the siliceous variety is so cherty (No. 10), that it appears a cherty slate, with thin films of pyrites; the beds, however, are not distinctly separable, although a rude dip can be traced in them to the south, at about 40°. Near Termon, thick veins of coarse massive epidote occur in the rocks, and again to the east of the road in small quantity; while a little north from this point, the rock is traversed by thin strings of serpentine.

Before concluding this description of the igneous and metamorphic rocks, the granites of Slieve Gallion require a brief notice. The remarkable modifications which may be observed along the junction of these granites with the sandstone rock have been described, and the interesting fact of their repetition within the granitic area noticed. The granitiform structure of the schist in the adjoining range, and the general composition and relations of the more hornblendic rocks have also been mentioned; and it is therefore, only necessary to bestow a cursory glance on the granites themselves. If the rocks of the whole south-east face of Slieve Gallion had been considered, as heretofore, granite, the endless variety perceived in their composition and aspect, on examining an extensive suite of specimens, would, as a simple fact, when compared with the persistency of mineral character, which (within, at least, certain limits) is observable in most extended granitic districts, have led to a doubt that they were actually a rock, so uniform in character and supposed to be so simple in origin. It has been impossible, on a map of a small scale, to represent satisfactorily the position and extent of these numerous varieties; but so far as possible it has been done. It will be therefore seen that the crystalline granites, or those which, if derivative, afford, in their present condition, no sufficient evidence to determine the question of their origin, are confined to two belts, with irregular outlines, rudely parallel to each other, and stretching in a north-east and south-west direction (the general strike of the schists in the neighbourhood). In composition, they are very similar to those which have been already noticed at several points in Tyrone; in general very felspathic, of a light rose-red or flesh-red colour, with dark green talc or talcose mica; quartz is not abundant, and hornblende is an occasional ingredient. The presence of talc by which these rocks are assimilated to Protogene, seems common to all. Interposed between these two zones, there is a stripe of rocks, which, in general character, in cleavage, arrangement, and variety, resemble so strongly the more crystalline of the gneissose schists, that it is scarcely possible to hesitate in referring them to the same class. A small patch of scarcely altered schists is seen near the south edge of the sheet, adjoining the granite; and still farther up the same stream are observed quartzose slaty rocks, or talcose quartz rock, pyrites being abundant in crystals (Nos. 47, 48, 49). Farther north on the boundary of the parishes of Lissan and Desertlyn, the rocks are very similar, though slightly more granitic, whilst others are coarse confused aggregations of quartz and felspar, the quartz being in lumps and abundant. These do not differ from the rocks which may be seen to the west, near Lough Fea. Along the river, near Lissan, are found granitiform schists, forming the bed of the stream; they are talcose, and very quartzose; and a little north, at Clagan rock, they are syenitic, with epidote, presenting, within the immediate neighbourhood, all the varieties which have been already noticed. At the Harigan rocks, though still retaining their schistose structure, they are porphyritic, having large crystals of reddish felspar imbedded in the general mass. Attention has been previously directed to the remarkable and almost demonstrable metamorphism, which has taken place in the schists of Ballynascreen, where distinct crystals of hornblende have been numerously developed within their mass, whilst the original bedding is still preserved; and there is here, at the other extreme of the series, a similar development of felspar crystals. On the map is also marked a space occupied by rocks which, although identical with the altered sandstones along the line of junction, again occur within the granitic area. Combining, therefore, the indications of the map and the several sections with the foregoing detailed description, it is hoped that an accurate and distinct view has been given of a district, limited in superficial extent yet rich in the most instructive facts.

Wandering amidst rocks of so complicated a character, and witnessing every possible form of variation, the observer, stimulated to search for the cause of such variety, sees the full difficulty of the inquiry opening before him. It is easy to speak of metamorphic changes, but it is impossible to explain them. In the present district, gneissose schists have been observed to approximate so closely to granite, that, were a favorable hand-specimen alone observed, it would be difficult to decide to which of the two rocks it belonged; and in like manner hornblendic rocks have been noticed, which, in the appearance of their weathered surfaces, in their cleavage, and bedding, were closely assimilated to schists, although internally possessing the characters of finely crystalline greenstones. If, then, both these rocks be metamorphic, it may be reasonably asked what has induced the different direction of their change. To understand, however imperfectly, this obscure subject, it is necessary to turn once more to the ordinary micaceous and crystalline schists, described in Chapter VII.

In the numerous varieties occurring within the extensive district which they occupy, some peculiar forms may be separated as possessing a distinctive character, such as the clayey or very micaceous, the quartzose, and the felspathic or gneissose; and in each of these are observed modifications similar in kind, though less in degree, to those described. The felspathic become granitic by the more confused admixture of its constituents; the quartzose become quartz rocks of various forms—sometimes felspathic, at others chloritic, and are often not readily distinguishable from some of the forms of hornblendic rocks; and even the clayey become occasionally gneissose by the development of felspar crystals. Here, then, are transitions similar in direction to those observed in one form of the more fully metamorphosed rocks.

But besides the rocks which possess, as the mica schists do, at the same time an equally distinct sedimentary and crystalline character, there are others associated with them—the hornblendic schists—which often lose the sedimentary character, and assume the more purely crystalline one. In some examples of these rocks, where they appear as highly crystalline greenstones, and are even accompanied with a disturbance of the strata, as in Banagher, boundary of Dreen and Tamnagh, it is difficult to deny them an eruptive origin; whilst in others they are so perfectly associated in alternating beds with the mica schists, that it is as difficult to deny them a sedimentary one. Here, then, is an equally, or even more powerful illustration of the hornblendic type of change, than that which was afforded by the felspathic rocks of the granitic type.

The alternation of hornblendic rocks with the schists has been fully detailed in Chapter VII, and the curious combination formed by the millustrated at page 172; but there is a point connected with their development which deserves to be again noticed, namely, its apparent connection with the presence of calcareous rocks. In almost every instance of the appearance of hornblendic rocks in the County of Derry, limestone occurs at no great distance, either as a distinct stratum, or as thin filmy layers in the schists; and it is remarkable that the line of greatest development of the one is also that of the other: such a coincidence cannot be considered accidental, and it affords, therefore, a striking illustration of the nature of the more independent masses of hornblendic rocks, in which carbonate of lime still exists either as a constituent, or in veins and cleavage coatings. Nor is the combination of the schistose with the highly crystalline structure less remarkable in the one case than in the other. In the mica schists, the beds associated with the hornblendic rocks are usually highly indurated and quartzose; and though, in the greater mass, such forms of rock become more separated and independent, they do not the less exist. If, indeed, it were possible to conceive a series of the alternating beds of the schists, such as that near the old church of Dungiven, expanding into a vast size, it would become a representation of the great hornblende district described. Is it not, therefore, reasonable to believe that the presence of a calcareous carbonate has facilitated or induced the assumption of a hornblendic type in the modified micaceous schists; and in like manner that its more general diffusion through the mass has induced the great development of such rocks under a still more extended metamorphic agency—the presence of the carbonate being still demonstrable in the less altered rocks, but no longer so in the highly crystalline. The peculiar forms assumed by some of these rocks—such as the irony quartz, with its micaceous iron veins, and the diallagic and hypersthenic varieties—have been already fully noticed. The intersection also of these rocks by numerous quartz veins, dividing them into solid crystalline compartments, is also worthy of observation, and not apparently explicable on the eruptive theory; whilst the concretionary crystallization of the hypersthene is explicable on either theory, though the crystallization from centres, and the diffusion or veinous ramification through the mass, are perhaps more suited to a metamorphic than to a perfectly fused condition; and in like manner, the syenitic rocks, with their ochreous and serpentinous cleavages, seem readily referrible to such an origin. The appearances connected with the veins of quartz and serpentine, have attracted the attention of other observers, and led them to adopt similar conclusions. Dr. Lusser observes (Memoires de la Société Helvetique, 1842), "I have since observed that, not merely in elevated positions, but also in deep ravines, the homogeneous elements of the crystalline felspathic rocks are so blended together, that quartz and felspar, with a little mica or hornblende, form white veins, which are twisted and ramified together, passing through the rock in all directions, and becoming the partitions or walls of both large and small nests of various forms and of darker colour. These nests consist of a mixture of quartz, felspar, and mica, of hornblende or talc, of a hornstone-like mixture of quartz and felspar, of hard talc, of greenstone, or of segregating serpentine, and more especially so where the gneiss is rich in talc. This mode of development seems opposed to the opinion, that the serpentine had, through some subsequent plutonic agency, been injected through the beds, but rather seems to suggest that it had been formed cotemporaneously with the gneiss through metamorphosis, or in some other way; and that the large blocks of greenstone (Gabbro) and Schillerstein, which occur near Inschi, at the foot of the Griesstoek, were only fragments of such nests (concretions), of large size, and do not belong to any independent formation." This coincidence in the occurrence of diallagic and greenstone rocks, in the similarity of their arrangement and connection and in the variety of their composition is curious and highly illustrative of a constancy in the results of definite metamorphic agencies.

The evidence, therefore, of a metamorphic condition in the great mass of hornblende rocks is as complete as could be expected in so obscure a problem; and by the highly crystalline structure of some of them, the tendency of the change is shown to be towards an ultimate form, corresponding to that of the truly erupted greenstones of dykes. The ochreous and sometimes serpentinous cleavages, wedge-like fracture, and frequent passage into the more purely hornblendic rock, indicate a similar metamorphic origin for the syenitic varieties; and in proof of it, all the steps have been traced of the transition from the marly sandstones of the old red into such rocks. Here, then, a new element has been introduced in the presence of the secondary strata, and skirting the boundary between them and the hornblendic rocks, a peculiar red granite has been observed at all those points where they have most nearly approached to a direct contact. This granite is rich in red felspar, remarkably fissile, frequently calcareous, contains iron pyrites in crystals, and, on exposure, exhibits ochreous cleavages; it possesses, therefore, many points of resemblance to the felspathic rocks of the hornblendic series, including the calcareous character, which is also common to it and to the secondary strata, and is curiously exhibited in a very singular rock, in immediate connection with the hornblendic rocks at Lime Hill, which possessing the external aspect of a granitic rock, is a highly crystalline compound of felspar and carbonate of lime, with scattered scales of talcoze mica, and is even in part available as a limestone. Has, then, the metamorphic action stopped short of this granite, or did it extend over it? is the granite to be considered the proximate cause, or the ultimate result, of metamorphic change? If the latter, which is at least probable, the mutual reaction of various forms of mineral matter under the influence of a common cause, has induced the various observed modifications, whilst the progressive action of the exciting force is marked by the still further development of red felspar in crystals, or even granitic veins within the mass of the hornblendic rocks, and when fully perfected by the exhibition of pseudo-dykes, such as that of Tremogue Glen.

If, however, a derivative origin be admitted for this section of the granitic rocks, a question still arises on the origin of the more perfect granites of a portion of Slieve Gallion. The mind, accustomed to consider granite a great original rock, forming, as it were, the foundation, and by its disintegration yielding the elements of other rocks, feels a difficulty in rejecting the idea so familiar to it, although a close examination of that rock, and a comparison of its characters with those of gneiss, have already induced some geologists to modify their opinion, and to consider it a more highly altered, or even a fused condition of the sedimentary deposits; whilst in respect to its actual appearance at the surface of the earth sufficient proof has been afforded that, in some cases, it was posterior to the more recent secondary strata; and if such be the case, the ramifying veins which pass through the contiguous strata, and their indurated condition, are evidences, not of injection of the matter of the one rock into the other, but of the still extending granitic change. The more particular study of granite, and specially of the veins internal to its own mass, and external to it in the adjacent rocks, as well as the accurate observation of the modifications of its structure in different localities, and in approximation to different rocks, will hereafter elucidate, and perhaps solve the problem; and it will probably be then found that the cause of that persistency of character over large spaces which has been so generally remarked is due to a constancy in the circumstances attending it, the character of the granite only varying with the conditions of the strata, existing and in contact with it at the time of its development.

On this theory, as well as on that of original formation, or even of erupted elevation, its appearance at so many points—as, for example, in Wicklow, Galway, Mayo, Cavan, Sligo, and Antrim—is equally explicable, as the corresponding extension of trap dykes proves that the space over which igneous and metamorphic agencies have acted, and probably are still acting, as is shown by the shocks of earthquakes, is unlimited.

In the present case, the variation in the character of the granite, whatever may have been its origin, seems to be due to its relative position; in the one case, it has been influenced by proximity to the secondary strata; and in the other it is still connected with the crystalline schists by rocks, which have even assumed an intermediate or granitoid character.

In treating this subject, the object has been to describe the varieties observed rather than to name them according to terms of indefinite and uncertain application; by following the latter plan, the task would have been lightened, but the instruction would have been reduced to a mere knowledge of unmeaning names. A very few observations will now be advanced on the probable epochs of the changes or phenomena which have been described, a point to determine which, two methods of explanation may be adopted—the physical changes exhibited in elevations, and the chemical or metamorphic changes.

In respect to the evidence by elevations; if the schistose ridge of Fir Mountain, Ballynasollus, Beleevnamore, involved in the hornblendic or metamorphic district, be considered one of the effects of such elevation, it is so much in accordance with the other ridges of the ordinary mica schist as not to seem thrown out of its true relative position, and would, therefore, imply that the other ridges had also been similarly elevated; but within the limits of these schists, hornblendic rocks have also been observed, and it is, therefore, the more probable that a common cause has exercised its influence over the whole space, the principal action or metamorphic change being, however, developed along the line of the hornblendic rocks which have been here described. If this be so, it is equally probable that the more perfect granite and granitoid schists were cotemporary with the first great change, the date of which was anterior to the old red sandstone, the strata of which overlie the edges of the mica schist in the parish of Dungiven, and anterior to the upper beds of the silurian, as pebbles of the granite are found in the conglomerates connected with them. But the elevating process did not cease, as is proved by the disturbance and dislocations of the old red strata at Slieve Gallion, by the elevation of the lower beds of the carboniferous system in Ballynascreen, and at Kildress and Tirnaskea, and by their induration and metamorphic change. Whether the elevating force was exercised at several times within the periods referred to, cannot be determined: it is probable, however, that it was so, the fractured condition of the hornblendic rocks being one of its results, the ultimate elevation of the hornblendic and syenitic ridge another, and the spur-like arrangement of the mountain limestone ridges in Kildress, Desertcreat, and Derryloran, as well as the disruption and elevation of the shales by the elevation of the old red sandstone ridge of Slieve Gallion, a third. The date, therefore, may be carried down to an advanced period in the carboniferous system.

The chemical changes lead to the same results; the granite, so closely associated with the granitoid schists, has probably been the result of an action cotemporaneous with the earlier exhibition of the elevating force, and the granite so nearly connected with the old red sandstone the result of a later. This action is also observed to extend into the carboniferous system by the induration of the lower beds of sandstones and shales near Tirnaskea, and in Desertmartin; and it must of course have continued, within certain limits, to modify the results produced on the mica schists by preceding elevations and metamorphic agencies. How far such modification may have extended, it is impossible to say; but traces of it may be found in the raised crest of schist between Doan and Coolnasillagh, and in the small patch of syenitic porphyry in Clondermot.

In another form, metamorphic action can be traced in the felspathic porphyries, associated with the old red sandstone: and as the presence of true basaltic dykes here indicates the close proximity of a distinctly erupted rock, it seems not unreasonable to believe that the felspathic porphyries were beds of volcanic mud poured out successively during the deposition of the strata, and subjected with them to subsequent metamorphic action—a supposition strongly supported by the porphyritic character of the accompanying conglomerates, and by the manner in which, at one locality, as before observed, the porphyry descends, as it were, into the mass of the underlying conglomerate, and exhibits the appearance of a rude concretionary dyke.

Of all these rocks, the porphyritic conglomerates are not the least remarkable, and may well claim the closest attention. Filled with pebbles which supply specimens of all the modifications observed in the porphyry, they suggest the idea of a succession of porphyritic flows or beds, the destruction of a portion of which has supplied pebbles to the conglomerate succeeding it; but another idea may be advanced, namely, that the pebbles as well as the paste of the conglomerate have undergone metamorphic change, or even that the pebbles may in part be concretionary. In either case the general reasoning is not affected, whilst the course of the metamorphic change is shown to have been from below upwards, by the absence of any sensible diminution in its intensity, as the distance of the porphyritic conglomerate from the overlying porphyry increases.

For the present, this subject will be here closed; it is one of the highest geological interest, and, from its obscurity and complexity, is not to be fully elucidated or cleared of difficulties by the study of a single season, but will require the renewed inspection and the continued reflection of years.

A chemical examination of the porphyritic rocks described in this chapter is still required, in order to compare them efficiently with the results obtained by Abich, in his examination of the volcanic rocks, or lavas, of Italy. It is hoped that, in a future supplement, tables of the mineral constituents of the several varieties may be given similar to those contained in that author's recent work (Vulkanischen Erscheinungen, 1841).

CHAPTER XII.

CARBONIFEROUS STRATA.

On entering upon the description of this most important link in the great chain of geological formations, the difficulty, which has been already experienced, in the oolitic and cretaceous strata of determining the true relation of isolated fragments to a definite whole, is greatly augmented. In those formations, the fossil evidence and the general character of the strata have shown that the greater proportion of the western chalk should be classed with the upper or white chalk, the lower portion of the cretaceous system being reduced to thin marly or arenaceous beds, and in like manner that the oolites are represented by several distinct beds, some of which may possibly carry the formation beyond the liassic division; but the further evidence to determine how many members of those formations are really present, to allocate each to its proper place, and to show, for example, that the remarkable siliceo-calcareous bed, which contains Ammonites *Sampsoni* as a characteristic fossil, belongs either to the greensand, corresponding to one of Dr. Fitton's specimens, or to the oolites, must be sought in an extended conjoint examination, and careful comparison of the strata and fossils of the counties of Antrim and Derry. So also must the evidence for reducing to order the various members of the carboniferous system, isolated in position, varied in mineral structure, and obscure in their mutual relations, as they occur in Derry and the barony of Dungannon, be sought in an extended examination of, and comparison with, the more developed sections of the formation, as exhibited in Fermanagh, Leitrim, and Sligo. This was the design which had been marked out; and though it is for the present suspended, I still trust to carry it into effect, and to be enabled thereby to determine the actual number of distinct beds which can be traced in this great formation, and the subdivisions into which it may be reasonably separated. Till this is done, and the true order of superposition accurately determined, fossil lists can only prove blind guides, mixing up as one thing the data of totally distinct beds, and obliterating the traces of geological progression. This has probably been already done; and it is a subject of regret that, from so limited a district, the design which had been formed to remedy the evil can only be sketched out, rather than exhibited in its complete development from the data of more extended examinations. Of all formations, the carboniferous has, perhaps, suffered the most, from a tendency to give undue weight to local peculiarities, and to separate, as distinct sections, those members which, in reality, have only a limited range and importance—the yellow sandstone, the mountain limestone, the calp, the coal measures, and the millstone grit, becoming, by turns, the prominent local object, although they are all parts of one great system, characterized by the frequent recurrence of vegetable matter, and by a remarkable combination of limestones, shales, and sandstones, either of which may, in turns, become the predominant member of the system. This can be illustrated by the present district; for if the examination be commenced at the north, and carried round, the system at first appears to be almost exclusively arenaceous, as the limestones, if, indeed, this portion of the strata be actually carboniferous, are reduced to nodules, or nodular beds, irregularly disposed in the sandstones, which are usually calcareous, and the shales have comparatively even less extension. This is the condition of the formation in the northern portion of Derry, particularly in the parish of Dungiven, no true bed of mountain limestone occurring to divide the lower grits and shales from those which appear to belong to a higher part of the system. In the parishes of Ballynascreen, Maghera, Kilcronaghan, Desertmartin, the sandstones still predominate, but are now more mixed with shales and beds of impure limestone; and in the parish of Desertmartin, an extensive and well-marked member of the carboniferous limestone, for the first time, appears. The elevated limestone of Cullion, in the same parish, though at its base conglomeritic, and approximating to the old red, is probably, in part, higher in the system, as it corresponds to the limestone of Carnteel, and is succeeded by shales and grits, of which the shales produce a fossil group—Nucula *tumida*, Orthis *filiaria*, Spirifera *bisulcata*, Bellerophon *Urii*, Orthoceræ, &c.—strongly resembling that of the Paisley beds; these grits become more extensively developed in Tyrone, and the lower grits and shales less so. The limestone, corresponding to that of Desertmartin, becomes the predominant member in Derryloran, Donaghenry, and in Armagh, whilst in Donaghmore and Drumglass it agrees in mineral character with part of that of Cullion, though the fossiliferous group of Drumglass is peculiar and distinctive. The true carboniferous grits become predominant in Aghaloo and Clogher, associated with shales which, though forming a small portion of the whole mass, contain distinctive carboniferous fossils, and are underlaid by other shales; the shales also of the lower grits occasionally appear, though the grits have nearly ceased. In the eastern portion of Fermanagh, shales prevail at the base of the system, and limestones, shales, and grits may there be considered about equal in importance; whilst in western Fermanagh, Leitrim, and Sligo, shales and limestones attain their maximum of development, and rise into the fine mural precipices which characterize those counties. This review shows that the several members of the great carboniferous formation attain their highest development at different points, and, in consequence, that a comparison between distant portions of it is attended with difficulty, and requires caution.

In the aspect of the eastern and western portions of the limestone district, the contrast is so striking, that it cannot fail to suggest reflection. The road from Bundoran by Manorhamilton to Enniskillen affords a good example of the one case, in which the deposits of shale, grits, and limestones, though excavated into deep valleys, are still preserved in sufficient integrity to stand out as bold and elevated masses. The line of Lough Erne is the line of separation, as the shales, grits, and limestones, on the east of it, though still divided into ridges, no longer attain the same elevation, or exhibit the same grandeur of outline and feature, as on the western side. This is not merely a peculiarity of scenery, but indicates a remarkable variation in the mode of operation of the forces in the west as compared with the eastern portion, as the arrangement of the beds on the east is similar to that on the west, although, on one side, they are extended superficially, and on the other vertically. The limestone of the district farther to the east, is still more strikingly contrasted with that of the west; its ridges, where they occur, are low and broken, like those of Desertmartin and Derryloran, or that of Armagh; but more generally it appears in low and isolated projections, the connection of which is obscured by intervening detritus, or by flats surrounded by sand and gravel hills. These are smooth and rounded, whilst the lake-like space between them is either still occupied by water, or is now a bog. The general effect of this arrangement of rounded hills enclosing an amphitheatre of bog or water, is highly characteristic, and has already been noticed; but it can be studied nowhere to greater advantage than in the country extending from Dungannon to Castle Caulfield and Donaghmore, and especially along the old road leading north-west from Castle Caulfield, where the road passes through a boggy flat, which is so perfectly enclosed by a chain of hills as to appear to have no outlet, whilst the bog itself is so dark, even, and flat, that it looks as if the water of a lake had only just abandoned it. This feature admits of great embellishment, and wherever it has been perceived, and the natural advantage of form heightened by planting and other embellishments, the resulting effect has been a soft and quiet beauty, unique of its kind.

The peculiarities in the physical condition of the strata at different portions of this district having been detailed, it becomes evident that the low position occupied by the limestones in the eastern portion, and the want of natural sections, render the determination of their geological sequence a work of much difficulty and doubt, heightened by the variation of mineral type they exhibit. To determine the subdivisions which ought to be admitted, a general comparison should be made of all the detached portions of the system—first with themselves, and secondly with the supposed corresponding strata in England and Scotland; but as this has not been possible in the present case, the subdivision here adopted can be only assumed as provisional, and the grounds upon which it is adopted may be thus explained. And first as regards the district itself. Immediately succeeding the old red sandstones of Derry, there is an extensive development of grits, which are sometimes reddish, sometimes white or yellow, and are associated with beds of shale and thin layers of impure limestone. Of the limestone which thus alternates with the shales, it is remarkable that its colour and general appearance conforms to the dark colour of the shales, although both the impure nodular beds associated with the lower grits and the first distinct mountain limestone of Desertmartin, possess the reddish hue which is preserved through Derryloran, Desertcreat, Kildress, and Armagh ; and it may be therefore assumed that, if the shales had been here predominant, the first great bed of limestone would have possessed the dark hue of that of Donegal. Hitherto the more common carboniferous fossils have not been discovered in these beds, although some of the shales are rich in fossils ; and they appear, therefore, to form a distinct group. But even in this respect, within a very limited space, as, for example, in the vale or expansion of Ballynascreen and Maghera (Plate D., figs. 1, 2), there is a considerable difference in the apparent results. Along the course of the Altagowan River, which, running nearly in the strike of the strata, exposes comparatively only a small number of the beds, the shales are rich in fossils of a few species, particularly in the several varieties of Modiola (Plate XXXIV., figs. 13, 14, 15), and the limestones occasionally contain a Serpula, here named Serpula *sub-annulata.* These beds are, like all the shale beds of the carboniferous system, subject to many faults (Plate C., figs. 13, 15, 16, 17, 18), and from their glossy and bituminous aspect, as well as the presence of ironstone, have a strongly carboniferous aspect ; they are overlaid by a reddish grit (Pl. C., fig. 21). Entering the Moyola, calcareous shales again appear, and in them is found the remarkable group, consisting of—Holoptychius *Portlocki* (Ag.), Gyracanthus *formosus*, G. *tuberculatus*, Cypris *Scoto-Burdigalensis*, Limulus *Trilobitoides*, large flattened stems of a Calamite encrusted with a minute Spirorbis, apparently the same as that which covers the exposed abdominal crust of Dithyrocaris *Colei* (Pl. XII., figs. 3 a, 3 b), a group which is almost identical with that of the Burdiehouse limestone. Here, then, there is a strong resemblance to the Scottish strata, more particularly as in both cases the base of the system is similar.

Dr. Hibbert observes (Trans. R.S.E., Vol. XIII., page 240)—"A sandstone, which perhaps holds the lowest place in the carboniferous system of the great lowland valley of Scotland, is composed of fine, yet very uncrystalline grains of siliceous matter ; it contains little mica ; it is of a deep red colour, owing to the iron which is diffused throughout it, and it is of a soft consistence. This, the most deep-seated bed, rises to day in a few places only, and is probably of marine origin." And further, "Gracemount system consists of nearly vertical beds of freestone of a light yellowish colour, and containing mica as an ingredient. There are many varieties of the colour, as light yellowish grey, or even pale red; some of the strata enclose very small attrited portions of quartz, as well as of a substance, which, from its more siliceous and argillaceous character, and from its grey and bluish-grey colour, may be considered as the detritus of older grauwacke beds. In other localities of the sandstones, which hold a similar place in the carboniferous group of the Lothians, vegetable remains have been found, though sparingly."

But although in this one spot a local result has been obtained, so perfectly in unison with the equally local one of Burdiehouse, the section of the White Water, near as it is to that of the Moyola and apparently connected with it by very similar circumstances, exhibits a very different result. The Modiolæ of the Altagowan are present, but the section nowhere exhibits the varied fish remains of the Moyola. Cephalaspis? Pl. XIV. A, fig. 11, Dithyrocaris *Colei*, D. *orbicularis*, Posidonomya *complanata*, of which the latter only is abundant, and that in a limited space, are the fossils which give peculiarity to these beds, and together form a group quite distinct from the preceding. These shales, grits, and impure limestones succeed immediately to the mica schist, and are followed by conglomerate beds, so that the type approximates to the old red sandstone; and were it not for the Scotch carboniferous analogy of the genus Dithyrocaris, they might be even transferred to that formation. Viewing them, however, as only varying, or more probably distinct, beds of a section below the first great member of the mountain limestone, they become, in part, parallel to the united beds of the Altagowan and Moyola, and it is probable, by the Posidonomya layers, carry the section somewhat lower down; they are capped by the mountain limestone of Cullion. The Dithyrocaris *Colei* again appears in Tyrone, parish of Clogher, in shales similar both in character and in their relations to the old red sandstone; but the Modiolæ are the fossils most characteristic of this section of the shales, and, therefore, most useful for tracing and defining it, as will be seen hereafter. The parish of Kildress affords another type of the lower section, where, on the Kildress River, is seen a remarkable series of alternating beds of red micaceous grits, red shales, conglomerates, and red impure limestones, with lumps of quartz imbedded. At Hartnes's House, about 19 feet of this deposit can be traced downwards: in this limited space it may be divided into 16 distinct beds, which, from the frequent variation of the mineral type of the deposit, strongly exhibit the corresponding changes which must have taken place in the forces which produced them; they may be enumerated downwards thus :—

		ft.	in.
1.	Composed of two thin layers of reddish grit, upper layer fossiliferous, ...	0	9
2.	Thin layers of red marly shale, ...	1	1
3.	Calcareous, close-grained grit or impure gritty limestone, with traces of fossils, ...	0	7
4.	Conglomeritic bed at top, with impure limestone below, containing imperfect traces of fossils, ...	1	0
5.	Very hard and tolerably pure limestone, . .	1	5
6.	Red shale, with calcareous nodules, having a highly calcareous and hard grit at the bottom, . . .	0	8
7.	Hard conglomerate, paste in part calcareous, pebbles principally quartz, with some of limestone, . .	1	1
8.	Hard conglomerate, the same in character as the preceding,	1	7
9.	Very compact conglomerate, still in part calcareous; pebbles quartz and limestone, ...	2	4
10.	Compact calcareous grit, or impure limestone, . .	0	9
11.	Two layers of highly calcareous compact grit, or impure limestone, ...	1	3
12.	Calcareous grit, ...	0	7
13.	Hard calcareous grit, ...	1	6
14.	Two layers of similar grit, ...	0	7
15.	Compact, hard, calcareous grit, or impure limestone,	0	6
16.	Four layers, very compact and calcareous, partly approximating to the character of sandstones, and partly to that of limestone; imperfect traces of fossils, .	3	4
	Total, ...	19	1

This curious series of beds, which, from the augmentation of calcareous matter, become in part impure limestones, illustrates the similar calcareous beds which occur in that portion of the grits, which stand, as has been stated in Chapter X., on doubtful ground, between the old red and carboniferous sandstones: there is here, however, a manifest approximation to the character of the distinct mountain limestone which occurs next in the series, and that not only in mineral constituents, but also in the fossils, which form a group not noticed in any other part of the district examined.

From the rough or gritty nature of the principal fossiliferous bed, the fossils are not easily identified.

A Spirifer (Pl. XXXVIII., fig. 2), or Atrypa, is the most characteristic shell of the deposit, and nearly covers the gritty bed; it exhibits several varieties of form. The dorsal valve is grooved up to the beak, and is sometimes elongated to the form of S. *canalis* (Murchison); at others is nearly pentahedral, and resembles S. *plano-sulcata* (Ph.); the more general form, however, being that of S. *unguiculus* (Sow.) The ventral valve is also grooved, sometimes strongly, from the beak downwards; at others slightly, the groove being linear, and often not extending to the margin. This valve is also more or less tri-lobed, as in S. *globularis* (Ph.), the character becoming, in some cases, obsolete, when the shell is identical with S. *unguiculus*. The lines of growth are more or less distinct, sometimes almost imbricating the shell. The tri-lobed ventral valve seems to require the separation of this shell from S. *unguiculus*, and it is, therefore, here named Atrypa *sublobata*. Associated with these shells, are many plicated Terebratulæ and Spiriferæ, belonging probably to three or four species, two of which are figured for illustration, and it is remarkable that they are all small.

SPIRIFERA *partita*—(Portk.)—Pl. XXXVIII., fig. 3.

A small shell, ·2″ long and ·35″ wide. Dorsal valve, with a deep sinus, extending to the back, and in the casts marked by a central linear furrow; the ventral valve with a rounded central rise, marked in the centre by a linear furrow, approximating it to S. *pinguis*; the sulci between the central plait and the lateral costæ strongly marked; the number of lateral costæ variable, being sometimes only three, and at others six on each side. The general form rounded, approaching that of S. *speciosa*.

TEREBRATULA *ferita* ?—(Von Buch)—Pl. XXXVIII., fig. 4.

Small shell, length ·2″; two or three strong lateral angular plaits or costæ on each side. In the deep angular sinus of the dorsal valve, is a slight central rib or elevation, rather stronger than in Von Buch's figure.

And to them should be added the following remarkable shell, which approximates to one found in the limestone of Derryloran.

INOCERAMUS *Pernoides*—Pl. XXXVIII., fig. 5.

This shell is doubtful in its generic position. It is elongated; length two inches, greatest width one inch; beak slightly curved, and an obscure ridge extending to the margin, so as to form a steep anterior side. Hinge line straight and oblique, forming an angle of about 30° with the frontal ridge. The Derryloran shell is more gibbous and incurved, and may be called I. *gryphus*.

The fossil group of this locality may, therefore, so far as at present known, be summed up thus:—

CRUSTACEA.—Trinucleus; fragments of cephalothoracic margin.

HETEROPODA.—Bellerophon *globatus?*—Some of the casts in the hard calcareous layers may possibly belong to this species, which appears to have been originally established on casts alone, and cannot, therefore, be considered well determined. B. *hiulcus?*—In the third layer some of the casts are large, and may belong to this species, in which the casts are always smooth.

GASTEROPODA.—Buccinum *imbricatum*—A cast in a more calcareous layer.

CONCHIFERA.—Terebratula *ferita* (Von Buch)—T. *crumena* (Sow.), T. *lacunosa?* Atrypa *sublobata* (Pl. XXXVIII., fig. 2), all in the red gritty fossiliferous bed, and abundant. Spirifera *partita* (Pl. XXXVIII., fig. 3); abundant, but not so much so as A. *sublobata.* Orthis *umbraculum:* principally impressions of the flat valve. Leptæna *antiquata?* casts principally of the ventral valve. Amphidesma *axiniformis?* a doubtful species, in the quartz grit. Pecten *ellipticus?* P. *hemisphericus?* in the quartz grit. Cypricardia? *tricostata:* doubtful, the costæ being obsolete. Unio? (Pl. XXXVIII., fig. 6): a doubtful shell, with a deep impression near the beak. Inoceramus *Pernoides* (Portk.), only one specimen.

In geological position immediately above these alternating grits, conglomerates, and impure limestones with lumps of quartz imbedded, is a red shale containing Orthis *filiaria*, and the abdomens of true carboniferous Trilobites; and still higher up in the red limestone are Euomphali, identical with those of Cookstown.

The group, in its principal elements, is carboniferous, but there is a mixture of silurian fossils, and of some of a doubtful character, which are probably Devonian, whilst the mineral type of the old red is preserved throughout; however limited, therefore, in space this deposit may be, it affords the nearest approximation to the Devonian type of any in this district, and differs widely from the two preceding assemblages of shales, impure limestones, and grits; or shales, impure limestones, grits, and conglomerates. It constitutes a third type of the lower division of the carboniferous system. South-west of Lisnaskea, in the parish of Desertcreat, a limited development of grits and Modiola shales is observed, which corresponds to the Altagowan type. This deposit, from its position in the country, has an appearance of overlying the limestone of Lisnaskea; but it is highly probable that this is only illusory, as no connection can be traced between them, nor can the sandstone which principally overlies the shales, which are low down in the river bed, be traced beyond a very limited space; and the highly indurated character of the sandstone, and of some of the shales, indicates that they have come within the range of the metamorphic agency, manifested in the adjacent hornblendic rocks, and have suffered a partial spur-like elevation.

The shaly portion of this deposit corresponds also to that of Ballynascreen, in the presence of a strongly marked turreted shell, distinct from, though nearly allied to Murchisonia *angulata*, which may be thus described:—

MURCHISONIA *elongata*—(Portlock).

Much more elongated, and with a less rapid increase of whorl than in M. *angulata*. Five whorls in ·5″, the diameter of the last being ·4″. Whorls angular; one thread-like keel or cincture immediately above the angle, and in some specimens two others; but this character may possibly be variable. The keel next to and under the angle is removed so far below as to become a distinct body cincture, and there is another similar cincture between it and the suture. The base of the last whorl is cinctured by the two keels, and is rounded.

The group is small; the characteristic Modiola not abundant; an obscure shell, somewhat in form like Phillips' Nucula *undulata*, rare; Cypris, and a few obscure traces of plants. Associated with the shales, are thin layers of fine, micaceous, shaly grit; and towards the summit, in a red calcareous bed, occurs Syringopora *geniculata:* the summit, therefore, of the aggregate may be considered as probably on a parallel with the red limestone of Lisnaskea.

About one mile and a half to the south of this point, on the boundary stream between Kiltycla and Drummillard, are highly indurated calcareous shales, which are vesicular, the cavities being occupied sometimes by calcareous spar, and at others by quartz crystals. This is a very limited deposit, and, though immediately following the underlying grits, and itself underlying the true limestone, its type is nearer to that of the mountain limestone than in the preceding cases, as the genus Cirrus (Euomphalus) is abundant, the species being the smaller variety of Euomphalus

Dionysii (Cirrus *rotundatus*). It may be doubtful, therefore, whether this very limited patch does not belong to the lower portion of the limestone, or the second section of the carboniferous system.

The next shales, which appear to belong to the lower section of the system, occur near Ballygawley, where they rest upon, and dip from, the northern side of the old red sandstone spit, and underlie the limestone which is deposited in the trough between this spit and the great northern mass; the aggregate is composed of dark shales, covered over with Modiolæ, and of impure calcareous layers, some of which become tolerably good limestone. The fossils in the limestone cannot be satisfactorily determined, but there are a minute gasteropodous Mollusc, which may possibly be the young of Natica *plicistria*, and minute, finely plicated Terebratulæ, which are probably of two species—one without a mesial fold, Terebratula *radialis;* the other with a mesial fold, and not identifiable, though exceedingly like a lias species. To the other layers may be added one which is very hard gritty and slightly calcareous; and it may be observed that some of the more gritty or earthy layers exhibit pseudo-morphous crystallization on their surface, and are intersected by thin calcareous veins. The principal portion of this deposit is highly calcareous, and, after exposure, might be used on sandy soil for manure. The shales and the hard calcareous layers continue into Sheet 59, occupying the same relative position.

The fossil group of these localities is very limited in species; but the abundance of the characteristic Modiola in the shales proves that they belong to the lower section of the system, although there is an approximation, particularly in the limestone associated with them, and in a portion of the shales which abounds in plants, to the next section, or true mountain limestone. In the parish of Clogher (Sheet 55), the shales skirt the southern edge of the old red sandstone, and dip to the south, or in an opposite direction to those which border the northern edge of the spit of old red on the south. About three-quarters of a mile south of Killyfaddy demesne, on the Black Water, the shales are nearly horizontal, and the Modiola layers are associated with a layer the laminæ of which are thickly covered with Dithyrocaris *Colei* (Pl. XII.); the apparent dip of the strata is very trifling, about 6°, but it is probable that the larger portion of the Modiola beds is above the Dithyrocaris layer; the only other locality within the district, where the Dithyrocaris has been noticed is the White Water, County Derry, and the correspondence between two such distant localities is very striking. On the west of the sheet, near Edergole, the character of the deposit is greatly varied; grits become predominant, and conglomerates of a high colour, and full of quartz pebbles, enter into the aggregate, affording another striking analogy to the White Water deposits, though in this instance the grits show traces of plants: if, therefore, the deposit of conglomerate and grit be taken in connection with the Dithyrocaris shale, the aggregate is, as a whole, the same as that of the White Water. The Killyclogher deposit, near Omagh, is another repetition of the White Water, the Modiolæ being here associated with the characteristic Posidonomya *complanata*, though other elements also enter into the composition of the group. The type of the shales and hard calcareous layers, under the town of Omagh, though they are still below the first great limestone, is more distinctly carboniferous.

Turning now to the base of the system in Donegal; on passing from the limestone of Pettigo, through the parish of Templecarn to the mica schist, a very narrow stripe of the old red sandstone conglomerate, only 40 yards in horizontal thickness where intersected by the section, and at other points almost evanescent, underlies the lowest member of the carboniferous system. Ascending geologically from the old red sandstone, a buff-coloured grit commences the formation, which gives way to shales, with impressions of plants. The shales are, at first, broken by alternating beds of grit, and then by beds of limestone, possessing characteristic fossils of the true mountain limestone, such as Producta *comoides* (Ph.), and then increasing in magnitude, terminate upwards in the Pettigo limestone. It is remarkable that in this aggregate of highly calcareous shales the characteristic Modiola beds do not occur; fossils of any kind are rare in them, and prior to the appearance of a true mountain limestone bed are merely traces of plants. The shales nearer to Pettigo contain true carboniferous fossils, Producta *pustulosa*, &c., and amongst them is one apparently new species, which is figured in Pl. XXXVIII.

LUCINA *Du Noyeri*—(Portlock)—Pl. XXXVIII., fig. 12.

Depressed, orbicular, slightly oblique; beaks not prominent, and near the anterior end; shell marked by very fine concentric, thread-like striæ. Dedicated to Mr. George Du Noyer, whose skill in drawing the fossils delineated in this report, and whose other merits, deserve to be commemorated. Nearly allied to L. *proavia* (Goldfuss). Eifel.

As the grits of this locality predominate in the lower portion, and the shales are only slightly fossiliferous, the fossils being plants, the aggregate more nearly resembles that of Altmover Glen, near Dungiven, though the red marly beds marking the descending transition to the old red are here wanting. Another peculiarity is, that the lower great mountain limestone, or second member of the formation, is broken up by shales, and descends, as it were, lower down, the first shales corresponding to those of the grits below in deficiency of fossils, whilst the upper shales contain many fossils, and those distinctive of the carboniferous formation. And it is equally curious to observe the abrupt transition from fossiliferous to comparatively non-fossiliferous beds, exhibited by the limestones and lower shales, the former containing the characteristic mountain limestone fossils, Productæ, &c., the latter traces only of plants. The whole section (Plate G., fig. 6) is highly illustrative of the local variation in the type of a formation, and of the necessity of investigating the circumstances, as well as the nature, of a deposit.

The alternating sandstones, impure limestones, and shales, which have been passed under review, seem, as a deposit, to have been anterior to the first great development of mountain limestone, and, therefore, on a parallel with the "alternating sandstones and limestones," or transition member of Professor Phillips; with a portion, also, of Mr. Griffith's yellow sandstone; and if the Donegal section were alone considered, with the lower limestone shales of Buckland and Conybeare, as exhibited in the Bristol carboniferous system; and again, if the Moyola section be adopted as the standard, with the lower portion of the Scottish carboniferous strata; but before finally leaving this question, a few more remarks are necessary on the Moyola and its connected localities.

The number of fossils obtained by Professor Phillips from his transition member were few, and those truly carboniferous; in like manner, the fossil species are by no means numerous in the Irish deposit, but they vary in different localities, do not correspond to those of the corresponding English deposit, and possess a more distinctive character. The local variation is evidently due to the varied circumstances under which the deposit took place; in the Moyola portion, so peculiarly interesting from its rich fossil group, and its accordance with the deposit of Burdiehouse, such a modification, from peculiar circumstances, is demonstrable, and is shown in Pl. E., fig. 6. A little removed from the line of section, a small patch of conglomerates, here considered the old red sandstone, is exposed in the bed of a small stream, and being assumed to be connected with the reverse dip of the strata opposite to it in the Moyola, is brought into the section. It would appear that on this ridge or reef was deposited a bank of sand, now constituting the hard grey grit, which is extensively quarried at this point; in its lower beds, the grit becomes very micaceous on the faces of lamination, and forms a micaceous sandstone slate, corresponding exactly to the schistose sandstone near Maghera, which also exhibits a double or transverse dip, and has, doubtless, been subjected to the same modifying cause, a faintly marked anticlinal line being traceable by the varying dips from one to the other locality.

On the west, or inner side, of the bank, is a deposit of shale, visibly more than 15 feet thick, and divided into several beds by impure limestones. In the shales are concretions of limestone, which sometimes produce the effect of a pebbly bed, and the hard calcareous layers break with an irregular angular outline, so as to form in the bank a serrated cornice. In the lower portion of the shale, the Holoptychius scales are found in abundance, as well as the teeth; and in a bed acquiring, from concretions, the character of a pebbly calcareous clay, they are mixed with the spines and bones of Gyracanthus, associated with plants, the bark of which is frequently changed to a pure coal, their stems passing sometimes vertically through the beds. Here, too, as before observed, a fragment of either Amblypterus or Palæoniscus was found, and a more perfect specimen has been since obtained by our former collector, Mr. Patrick Doran, employed for this purpose by Mr. Griffith. The general character of the group has been already stated, and it is only at present referred to on account of its position. East of the nucleus of grit, the sandstones and shales (the locality of the Limulus) again appear, dipping to the east at Forge Town Bridge; but they no longer possess the same richly fossiliferous character, and this seems to be a strongly confirmative proof of the modified character of the other portion; in short, the elevated neck must have shut in the shales and grits, and formed a quiet pool, within which the plants and other fossils were accumulated. That it was a marine pool, probably a portion of an estuary, is shown by the numerous Spirorbis attached to the plants; and the generally quiet character of the deposit, after a certain epoch, marked by conglomerates, is shown in the regularity of its arrangement on the Altagowan, where it even seems to have been subjected to the scooping action of currents, more resembling tidal than deep marine currents, as is seen in the hollows of its surface, filled up by the overlying sandstone (Plate C., fig. 21). The Altagowan River is also a locality of the Holoptychius, but the shales are more remarkable for the great abundance of Modiolæ and Amphidesmæ, some of the layers being thickly covered with them. Many of the shales are coated with a thin film of iron pyrites, and have a very pretty appearance. As the river runs in the strike of the strata, the actual section exposed is very small; the upper portion can be estimated from one point of the river, and the lower from another; and the general arrangement of the shales, as well as the faults which have dislocated them, are represented in the small sectional views on Plate C., figs. 15, 16, 17, 18.

Ascending the river from the road, the shales, at their first appearance, are capped by a bed of calcareous clay, with numerous chalk pebbles; the underlying sandstones are hard, calcareous, and micaceous: the visible portion of shale is here only four feet six inches thick. As the shale thickens, hard calcareous layers enter into the aggregate, and fossils become abundant; they are not promiscuously mixed through the mass, but appear confined to a distinct layer, and often to a portion of that layer, a circumstance noticed also in the White Water and other deposits. In one spot, the series of beds appeared to be—

	ft.	in.	
Shale, ...	1	6	brittle and hard.
Hard calcareous band, . . .	0	3	slightly calcareous.
Shale, ...	2	0	rotten.
Hard calcareous band, . . .	0	4	
Shale, ...	1	0	crumbly.
Calcareous band, ...	0	4	
Shale, ...	1	3	fossils.

This fossiliferous bed can be traced for some distance up the river, as well as the calcareous bands, which vary both in thickness and in their distance from each other; on weathering, the bands exhibit a curious nodular structure, and at one point a micaceous calcareous bed appears in the bed of the river, probably four feet thick, and divided into layers of one foot thick. The sandstone caps the shales, and it is not probable that the total thickness of the upper shales of the Altagowan much exceeds twenty feet. At the point represented (Pl. C., fig. 21), there has been considerable disturbance; but the impression conveyed by the locality is, that the great superincumbent mass of sandstone had descended into the soft shales; and, following the line of the sandstone, it appears to diminish in thickness, the bottom face being undulated, and waving into the shales. Here, there is a change of character, approximating the deposit to that of the White Water, by the introduction of conglomerates, and the section becomes—

	ft.	in.	
Hard sandstone, .	5	0	micaceous and calcareous.
Shale, . .	2	0	
Conglomerate, .	0	6	calcareous, pebbles few.
Rotten shale, .	3	5	under portion schistose.
Sandstone, . .	1	9	upper portion conglomeritic, calcareous.
Shale, . .	4	9	brittle, and brown in colour.
Sandstone, . .	2	4	calcareous, in thin layers.

Below this, in the bed of the river, is a very hard grit. The shales have frequently a highly bituminous appearance, and the most abundant shells, Modiola *Macadami* and Amphidesma *axiniformis*, though associated together, predominate in distinct layers. There are some very fine Septaria in the shales, and elongated, rounded, but rather irregular bodies, which separate into joints, but cannot be determined to be organic. Like most deposits in which shale abounds, it is dislocated by numerous faults. On the Moyola, similar calcareous bands to those here described occur in the shales, overlying the principal Holoptychius bed, sometimes, as is also the case on the Altagowan, becoming mere layers of nodules. In both these instances, the calcareous layers appear penetrated by Serpulæ? sometimes closely crowded together. The sandstones are often very micaceous and slaty, and display, on their surfaces, fine examples of ripple markings, and in the Moyola of pseudo-morphous crystallization. In the White Water, the calcareous bands are thicker, and the section is complicated by the introduction of conglomerates (see Pl. E., fig. 8). The bands merge into limestones, and in one locality a bed, two feet thick, contains minute Terebratulæ, probably T. *radialis* (Phillips), and Orthoceras *gregarium?* whilst in the portion higher up the river, where the shales are both associated with and overlaid by conglomerates, Lingula *mytiloides* occurs in thin calcareous layers, separated from the shales above them by a layer of conglomerate, one foot thick.

Taking the three rivers together, the fossil group is distinctly carboniferous; but even when combined with those of all the other localities mentioned, the total represents but a very small portion of the fossils of the great carboniferous formation, whilst in the mode of grouping there is a character of individuality partly due to geological position, and partly to the physical conditions of the deposit, as may be seen hereafter, when the Modiola beds will be found to occur in positions either corresponding to a higher section of the formation, or in which they must have been brought into contact with the beds of such upper section, in consequence of an original irregularity of surface or of subsequent elevation, a question which can only be satisfactorily solved by the close examination of the more perfect sections of Fermanagh, Leitrim, and Sligo. The present inquiries have gone no farther than to exhibit the peculiarities of the beds, which appear highly characteristic in several cases, and then become doubtful in others, and thus to prepare the way for a solution of the question.

The Altmover Glen, near Dungiven, has been so often referred to, that it is only necessary very briefly to notice it here. It is remarkable, as exhibiting an aggregate of red marly or clayey beds, impure limestone, close hard grits, and shales, with plants.

In a quarry near the parish boundary, the succession upwards is:—

	ft.	in.
Sandstone, seamed with little nodules of green clay.		
Green sandy shale, ...	3	6
Sandstone, ...	5	0
Black shale, with plants, ...	very irregular.	

And near this occurs white and slightly calcareous sandstone, having a bed of impure limestone included in it, and resting on a seam of thin bedded micaceous sandstone, which is partly divided by a large lenticular mass of the whitish sandstone. The sandstone is irregularly bedded, and obliquely laminated, and the succession appears to be, felspathic sandstone overlying a thin seam of shale, with fragments of Pecopteris ? ; a bed of impure limestone, two feet thick ; twenty feet of felspathic sandstone resting on deep red shale or marl, fifteen feet thick, containing nodules of impure limestone ; in some places this bed is very micaceous, in others it becomes indurated fine sand, and has also impressions of shells (Productæ ?), which are too friable to be preserved. Near the actual line of the section (Pl. A., fig. 4), a well marked space occurs on the face of the country, between the Altmover deposit and the Pellipar red shale with Calamites *Suckowii?*, and a small deposit of grits and shales, intersected by faults underlies the latter ; but at the Hass, before noticed, the under beds strongly resembling, in their micaceous sandy character, those of Altmover, are in contact, at a higher elevation, with the grits containing plants and fragments of culm, which appear to occupy a higher geological position ; and there are appearances of disturbance corresponding to this altered position. The Holoptychius scales of the Hass, and the character of the beds, bring the deposit into relation with the Moyola and Altagowan beds, whilst the reddish-brown shales of Altmover place it in relation with the underlying old red. The sandstones are very variable in character, generally calcareous, and sometimes contain calcareous concretions, as well as distinct beds of limestone, and at other times red clay nodules corresponding to those of the old red. In the northern portion of Faughanvale and Tamlaght Finlagan, the beds approximate more to the old red, contain no fossils, are often very loosely aggregated, becoming, on exposure, a fine sand, and rest unconformably on the mica schist (Pl. C., fig. 2). As a building stone, the more distinctly carboniferous portion is the most valuable, both from pureness of colour and closeness of texture. In the northern portion, and in Bovevagh and Dungiven, there is little appearance of disturbance, except in the case noticed at the Hass, and that appears a simple elevation ; but in the space between the Moyola and the elevated ridge of Coolnasillagh, there has been very great internal disturbance, the grits and shales being thrown down at a high angle, a very troublesome circumstance to the country people, who endeavour to quarry the grits, and find them sink rapidly down to a depth beyond their power of working; and again a small patch of the shales dip northward at a high angle from the elevated old red of Slieve Gallion, whilst another has been left on the crest of the ridge (Pl. E., fig. 7.) West of the Altagowan, in a small ravine, the Modiola shales appear, but they are probably only the prolongation of the same beds; and in the mass of grits more west, shales occasionally occur in considerable beds, as for example at the river, near Derrynoyd, containing the characteristic Modiola, and unconformably overlying the old red on the opposite side of the river. The elevated mass of grits along the face of Craignashoke is also interstratified with Modiola shales, which at the barony boundary contain scales of the Holoptychius at an elevation of 1475 feet. This portion has evidently been raised by an internal movement of the underlying mica schist prior to the deposition of the chalk, a thin layer of which, apparently undisturbed, passes over it; and the disappearance of the new red sandstone, and limited thickness of the chalk, seem the result of this more elevated position of the carboniferous strata.

It may be added, in conclusion of this notice of what is here deemed the lower section of the carboniferous strata, that the variations in its typical character deserve especial attention. In the Kildress grits, there is an approach to a Devonian system, or to a passage from the carboniferous to the silurian systems. In the alternations of shales, grits, conglomerates, and impure limestones of the White Water, there is an approximation to the type of Professor Phillips' transition member, or to a passage from the carboniferous to the old red. In the fossil group of the Moyola, there is a representation of the supposed lower member of the Scotch carboniferous formation; and in the Donegal beds, there is a nearly equal approximation to the base of the English carboniferous system of Bristol. This first or transition section is designated on the map 3 A_1 for sandstones, 3 Cs_1 for shales, 3 L_1 for limestones.

In entering upon the second section of this great formation, which is assumed to commence with the first appearance of a distinct mountain limestone, or with such an assemblage of the fossils of that formation as can leave no doubt that its boundary has been passed, the limestones of Kilcronaghan and Desertmartin first attract attention. As before observed, the grits and shales of Ballynascreen and Maghera rest upon the old red sandstone, and, from their position, appear to underlie the mountain limestone of Kilcronaghan and the east of Desertmartin, whilst a ridge of grit and conglomerate, connected with the lower shales of the White Water, underlies the elevated limestone of Cullion, and appears to rest on a raised portion of the old red (see Pl. E., fig. 7). The relative position of the limestones is very remarkable, for whilst the eastern beds crop out, as usual, from a boggy flat, and attain an elevation of only 250 feet, the Cullion limestone is raised to a height of 1047 feet; the dips, also, are very different; that of the eastern limestone to the east and north-east, and that of the Cullion limestone to the south-east. And again, the eastern limestones dip at a mean angle of about 17°, whilst the Cullion limestone dips at an angle of 34°. These differences are probably, in part, due to an elevation of the limestone of Cullion; but there are also other differences which indicate, even within this limited space, a considerable modification of some important characters. In the eastern beds, Productæ are abundant, and the character of the rock approximates to that of Derryloran and Armagh; in the Cullion beds, there is a mixture of sandstone and conglomerate, which indicates an analogy with the lower section, though the fossils are of the more distinctly marked carboniferous type. In ascending order, the Cullion deposit exhibits—

	ft.	in.
Sandstone, reddish, very soft and crumbly,	0	7
Limestone, in three beds, very gritty, fossils rare, or only seen on weathering,	3	0
Limestone, conglomeritic at bottom, with quartz pebbles, and having several intermediate layers of pebbles,	6	6
Shale,	0	6
Limestone, with shaly partings,	11	0
Calcareous conglomerate,	3	0
Limestone, visible,	5	0

When exposed by the removal of the gravel, the surface appears greatly worn, both in the line of strike and transversely in irregular fantastic forms. The principal fossils are—Lithodendra, Syringopora *reticulata*, Atrypa *globularis?* Orthis *crenistria*, abundant in shaly beds; Producta *antiquata* (rare); Producta *sulcata?* small var. (rare); Melania *rugifera;* Bellerophon *hiulcus?* cast; and, on weathering, minute Gasteropoda appear on the gritty surface, one of which, ·1″ in diameter, is beautifully marked with rounded longitudinal costæ; and another, ·2″ in diameter, approximating to the form of Pleurotomaria *sulcata*, is quite smooth, probably from wear, the band being low down, at the base of the whorl, as in that species. In the ascending order, limestone again appears lower down the hill, in the line of dip, and, though separated from the preceding, is probably an upper portion of the same series; it is rich in Productæ, and corresponds more in character and colour to the eastern limestone. Shales and grits belonging to a higher section of the formation succeed to the limestone of Cullion, and in this respect also it differs from the eastern deposit, in connection with which the upper strata have not as yet been discovered. The limestone of Cullion is of a dark grey colour, internally minutely sparry, and weathering with a light-coloured gritty surface, on which the fossils become exposed, characters which are identical with those of the first limestone, from the base of the system in Donegal. Some portions are lighter coloured and more crystalline, thus merging into the succeeding beds before noticed.

The Desertmartin limestone crops out in low broken ridges, and has evidently been subjected to great wear. The lower beds are massive, and are not distinctly separable into lesser divisions. At the quarry near the town this is particularly the case, a massive bed, twelve feet thick, being covered by another six feet thick, and the surfaces, as is usual in the limestone, being rugged and uneven, and at the top sometimes covered by a conglomerate-like layer of fragments, cemented together by the calcareous paste. North of this quarry, and apparently underlying it, the limestone is more broken up, becomes coralline, and contains a bed of calcareous shale, three inches thick, full of Lithodendron *fasciculatum*, a curious coincidence in the mode of occurrence of this fossil, here and in Desertcreat and Derryloran. If the beds were considered continuous, and in distinct superposition, the total stratigraphical thickness of the more marked portion of the range would be about 900 feet, and there would still be a small outcropping lump nearly half a mile to the dip in advance; but it is probable that the beds have little comparative extension downwards, are nearly horizontal, and have an absolute thickness of not more than one-half the stratigraphical.

The most characteristic fossils are the Lithodendra, Syringopora *ramulosa*, Astræa *hexagona*, A. *irregularis*, Solemya *primæva* (Ph.), Spirifera *senilis* (Ph.), Producta *hemispherica* (Sow.) small var., P.

aurita (Ph.), P. *antiquata*, P. *fimbriata*, Bellerophon *cornu-arietis*, Orthoceras *Breynii?*; the Productæ being the prevailing shells. The limestone of the lower beds corresponds in its dark hue and gritty weathering to the lower Cullion limestone, but the greater proportion assimilates to the higher, and to the pinkish limestone of Armagh, exhibiting like it dark red stains and patches. Though not abundant, Psammodus *porosus* has occurred in this limestone. Some of the Kilcronaghan beds are vesicular, the vesicular cavities being lined with calcareous crystals; one cleavage is nearly vertical, facing south 70° east, and the surface is greatly worn in small pebble-like depressions and long furrows. The summit of one quarry is much shattered. and a trap dyke is reported by the workmen to be very near it: this limestone ends abruptly at Desertmartin, but it is possible that it may be yet found more to the south, the ground being obscured by detritus. Entering Tyrone, the limestone is extensively developed at Cookstown, and at Cove Bridge to the north-west of it. The upper or eastern portion divides into beds, varying from seven inches to upwards of four feet in thickness; the colour is usually reddish of various tints, and red shaly beds are associated with it. The upper mass is separated from the lower by a fine grit, and the lower becomes very arenaceous, corresponding to some of the impure beds of the Kildress River. The most characteristic fossils are abundant, such as Favosites, Lithodendra, Astræa *basaltiformis*, Terebratula *flexistria* (Phillips), T. *pleurodon*, Atrypa *glabra*, Spirifera *striata*, S. *senilis*, Producta *fimbriata*, P. *punctata*, P. *Martini*, P. *antiquata*, P. *hemispherica*, P. *aurita*, Sanguinolaria *sulcata* (Phillips), Euomphalus *Bronnii*, Bellerophon *hiulcus*, Gasteropoda, Trilobites, and teeth of Psammodus and Cochliodus, and there are some peculiar to the locality as Macrocheilus *percinctus* (Plate XXXI., fig. 10), Nautilus *planidorsatus* (Plate XXXV., fig. 1). The whole group, as here exhibited, is most characteristically carboniferous. The Kildress limestone partakes of the same characters, but indicates, in its mineral type, an approximation to the lower division. The thickness of this mass is probably about equal to that of Desertmartin, and it is traceable southward and eastward towards Stewartstown, though probably with considerable local variation. The Loughry River exposes a section, in which two beds of grit are interpolated, and a remarkable shaly bed superimposed, containing small nodules of ironstone, which, on fracture, are found to contain Lingula *parallela*?

In the river, close to Loughry House, the limestone is broken up by shales; the limestone itself contains large Productæ and the shales Lithodendra, a peculiarity in the arrangement of these fossils, which has been before noticed. Again, near the road in Donaghrisk, the same limestone and associated sandstone appear, and a section is exposed, which shows extremely well how much this portion of the system approximates to the next section in ascending geological order:—

	ft.	in.		ft.	in.
Rubbly, . . .	2	4	Limestone, . . .	2	6
Limestone, . .	3	4	Impure calcareous band,	0	8
Red shaly rubble, .	0	11	Sandstone, (upper portion calcareous,) . . .	2	4
Impure calcareous band,	0	8			
Limestone, . .	3	0	Ditto, (very slightly calcareous,)	1	7
Rubble, . . .	0	7			
Limestone, . .	4	7			
			Total, underlaid by limestone, .	22	6

In the adjacent quarry are five layers of limestone, from one foot to five feet eight inches thick, the total thickness being fourteen feet; they overlie a grit, which is probably above the preceding beds, so that there is the same alternation as in Loughry River; and though the cross, or spur-like ridge, extending from Tirnaskea House by Rockdale to the Sandholes, is much broken up, the same association of grits and limestone, and the same singular arrangement of shaly layers of Lithodendron *fasciculatum*, and Lithodendron *co-arctatum* interposed between solid layers of productal limestone, can yet be traced. In this narrow spit, a circumstance is observed, which shows that it is not beyond the influence of the disturbing forces connected with the metamorphic rocks; at the western end, the dip is to the south-west; but suddenly on the line of strike it is reversed, and falls to the north-east, without any apparent reason for the change, and the latter portion of the ridge corresponds with, and blends into, the eastern division. It would be useless to say more here of the fossils than this, that the same general group prevails, though in every case local variations occur either in diminution, or in augmentation, of the general aggregate. Occasionally some marked peculiarity accompanies the appearance of a fossil, as, for example, in the case of Astræa *basaltiformis*, which is found filling a white siliceous layer in the limestone, just as the Lithodendron *fasciculatum* and Lithodendron *co-arctatum* had been noticed in shaly layers; and this layer is again noticed in Carnteel, affording a tolerable proof that the section of the formation, if not the bed itself is identical in both places.

Passing by the south-east corner of Sheet 38, a red gritty bed, associated with the limestone, contains Favosites *fibrosa*, which is another coincidence with the Armagh and Clonfeacle limestone, and, combined with the sandstone character of the bed, indicates the low geological position of the deposit. The ridge continues along the road, by Annaghone to Stewartstown, and, though broken, is bold and prominent. In the townland of Annaghone, the beds are variable, two, three, and more feet in thickness, massive in character, rugged on the surface, and of various colours, from light to reddish-grey, occasionally smooth and splintery in fracture, and sometimes, on weathering, displaying a curious concretionary structure: the seams and fractured surfaces when long exposed become ochreous. The beds seen in the quarry close to the road, on the top of the hill, are together fifty-five feet thick; the dip is about 17°, and there is an outcrop of strata both to the west and east of the road. At this point, the mountain limestone is overlaid by the coal measures of Annaghone, containing the same seams as those of the Annagher district in Coal Island, which are, therefore, in direct contact with a portion of the carboniferous formation assigned with good reason to the lower limestone: and a little to the north, geologically overlying the limestones, there is a remarkable yellow vesicular sandstone, the true relation of which cannot, at present, be determined. The Stewartstown limestone is a continuation of the same ridge, possessing the same characters, the beds being sometimes very gritty, as at the base of the system at Derryloran. This portion of the limestone is very interesting in its position, for as at Annaghone it underlaid the coal measures, it is here observed to underlie the new red sandstone, chalk, and basalt, which pass unconformably over it, the coal measures being deficient; and this circumstance seems another reason for believing it possible that, in the small space between the indip of the mountain limestone in Castle Farm, east of Stewartstown, and the outcrop of the new red and chalk in Ballybeg, some of the upper carboniferous strata may be found. At the quarry to the north-east, or the indip boundary of the limestone, a succession of strata may be observed similar to those before noticed in descending order:—

1. Close-grained, very light coloured limestone.
2. Earthy rubble bed, having harder masses disseminated through it, and appearing like some of the decomposed beds seen on the surface of other quarries.

3. Hard dense limestone, the joints and surfaces of the beds being coated with crystallized carbonate of lime. It abounds, as well as the uppermost bed, with Lithodendra and other fossils.
4. Thin-bedded impure limestone, used only for roads; at the bottom it contains an irregular seam of chert, about four inches thick.
5. Light coloured sandstone, with many veins and irregular nodules of calcareous spar.

Fossils, Productæ, Spiriferæ, &c., are abundant.

In descending, the colour becomes darker, and the rock more earthy. It rests on a dark rotten shale, three feet thick, which separates it from another bed of dark-coloured limestone, of very good quality. At the adjacent small quarry to the west, the chert bed is more fully seen, and appears developed in an irregular nodular layer, associated with a seam of greenish and purple clay which is between the beds, and fills the depressions of the limestone. The beds are here twisted and irregular. The same general appearances are observed in the next quarry, the upper portion being light coloured and sandy on weathering, thick bedded, and fractured, having a seam, six inches thick, of black shale under it, including concretionary masses of a dark earthy limestone. To this succeed three feet of soft, sandy, and decomposed limestone, and several beds of darker limestone, separated by soft blackish shale and traversed by thin seams of calcareous spar, which also coats the joints. All these quarries are shallow, the actual thickness of beds visible is but trifling, and the absolute thickness of the portion of the deposit connected with the three is probably not more than 100 feet; as however half a mile west of them the limestone is again exposed, close to the town, and as the dip is still about 15°, the stratigraphical thickness, if the whole could be considered in continuous succession, is very great. The limestone here is of a dark grey colour, hard, and dense, with thin seams of calcareous spar and is underlaid by a light-coloured calcareous grit, which, in decomposing, assumes a yellowish tinge. Between the limestone and grit is a thin seam of soft red, marly, micaceous sandstone, and, through the grit are dispersed spherical, concretionary nodules. The various layers differ in colour, and in the lowermost portion there is a stratum, one foot six inches thick, of purple, red, and blackish striped marl, or marly sandstone. This succession of limestone, grit, and purplish marl seems to make an approximation to the underlying old red, somewhat similar to that observed in Derryloran. To the east of the town, the quarries again admit of examination.

	ft.	in.
1. Earthy, with numerous hard shelly nodular concretions, producing a conglomerate structure, as before noticed, the nodules being arranged in thin layers, with some degree of regularity, .	6	0
2. Hard, thick-bedded, grey limestone, with rugged surface, ...	12	0
3. Earthy and nodular as above, ...	4	0
4. Hard, darker grey limestone, shelly, and traversed by veins of calcareous spar,		
5. Soft sandy shales, containing shells, probably Amphidesma, which are with difficulty preserved,	3	0
6. Hard, dark grey limestone, the lower bed being coarser, more granular, or scaly.		

The beds have been here dislocated by a small fault.

Proceeding into Sheet 47, past Mullintain, to the south-east in Gortatray, the ascending succession appears to be—

	ft.	in.
1. Limestone, thick-bedded, earthy, with some disseminated pebbles of quartz.		
2. Alternating beds of soft blackish-grey shale, and irregular lenticular masses of limestone, .	2	0
3. Limestone, ...	1	8
4. Shale, and thin layers of coralline limestone, the upper seam full of corals.		
5. Thick bedded solid limestone, with numerous joints, and much weathered.		

The shales are highly calcareous, full of fragments of fossils one of which was the pygidium of a Trilobite, a circumstance which deserves to be specially noticed, as no Trilobites have hitherto been found i the shales of the lower, or transition section. At Mullintain quarry, the same alternation is observed, and the rocks are a mass of corals of very large size, separated into several layers, and in their natural position. More to the west, and north of the new mail coach road from Stewartstown to Dungannon, the limestone is of a light grey colour, and similarly associated with shales, which are more sandy than the preceding; and immediately under it, geologically, is a remarkable succession of beds.

1. Reddish, non-calcareous, thin-bedded grit, two feet thick, passing into a coarser grit, highly calcareous, and speckled with grains of per oxide of iron,

2. Coarse conglomerate, in which quartz pebbles are abundant. and combined with large lumps of limestone. The arrangement is confused, and some of the pieces of limestone so large as almost to appear portions of a bed. This conglomerate is underlaid by a coarse reddish sandstone, non-calcareous, and thin bedded.

Very little of this is exposed, but the combination cannot fail to recall the conglomeritic structure of the lower section of the system at the White Water and Kildress, although the distinct character of the limestone will retain these beds in the second section, or lower mountain limestone. This district is illustrated by Pl. G., fig. 1. An inspection of the map, the general character of the limestone, and the correspondence in the characteristic fossils, are enough to show that the various beds which have been noticed form parts of one great section of the carboniferous formation, arranged on the east in a nearly continuous bank, reef, or ridge, and throwing out diverging ridges to the westward into the parishes of Desertcreat and Kildress. Passing over the parishes of Donaghmore and Drumglass, in which the limestone is arranged in a transverse direction, and, if not actually higher in the system, is at least more conformable in arrangement to the limestones of Carnteel and Aghaloo on the south than to those of the north, the line of the eastern range is apparently continued in the line of limestones, exposed by denudation from Moy to Benburb, whilst there is a still further and more extensive development of the formation extending over the parishes of Clonfeacle and Aghaloo, being here and there connected with grits, which are considered in this report superior, and not inferior, to the lower limestone. It would be useless to estimate the real thickness of the formation in this portion of the district by a reference to the dips and positions of the various quarries, since it is evident that, even at a very low dip, if the beds were considered successively continuous, the formation would possess a very improbable thickness. Such, however, is not their character; and if the eye be passed over the map, instances will be observed of reversed dips, which indicate a waved or ridge-like surface, by which the same portion of the formation may be frequently brought to light; it will be here, therefore, more instructive to inquire if any beds have a permanency of character, and what glimpses can be obtained in such unfavorably marked positions of identity of epoch. But before doing this, it may be well to pause for a moment on the prolongation of the lower limestone in the denuded space at Moy, where it appears over a considerable tract, but not in a bold or prominent face; in character, it corresponds to the northern range, and, being hard, the fossils are only seen, with difficulty, on weathering.

Within this space, the dips are variable, but at Benburb the limestone forms part of a distinct section, in which the dips are to the west. The order of this section (Pl. E., fig. 9) is limestone broken by shales; massive limestone the absolute thickness of which is about fifty feet, the stratigraphical very considerable; shale highly fossiliferous; alternating sandstone, limestone, and shale, the sandstones containing plants, and the upper portion of the shales having nodules of clay ironstone, very rich in fossils, among which is Producta *rugata* (Phillips); impure limestone, sandstone, and shale. Some of the shales in this section are peculiarly rich in fossils; Conularia *quadrisulcata* is found in great perfection; Venus *elliptica* and V. *elliptica* variety *bistriata;* Orbicula *nitida?* Orthis *filiaria*, Cidaris *Benburbensis*, &c.; and in the limestone, Productæ and Lithodendra, though, from its hardness, they are not extracted without great difficulty. In the preceding examination, nothing similar to this alternation of sandstone and shales has been noticed in direct connection with the limestone; but at Cullion, beds of sandstone and shale have been observed, as here, to overlie the lower limestone, and, like the shales, to contain Orthis *filiaria* in abundance, a fossil which again occurs in the shales associated with the grits of Clogher. It is highly probable, therefore, that these shales and grits should be classed with the upper limestone shale of English geologists, or using that term in a restricted sense, so as not to include the upper limestone of Bristol, with the third section of this report $3L_3$, $3\ A_3$, $3\ Cs_3$. If the limestone be followed into Armagh, the closest identity in mineral type is observed between the beds near that town, so rich in fossil fishes, and those of Derryloran, Desertcreat, and Desertmartin; and this is confirmed by fossil evidence; for, though the latter have not yet yielded so large a quantity of fishes, the two most characteristic genera—Cochliodus and Psammodus—have both been found there, and the red stains, which, according to Capt. Jones, invariably mark a fish locality in Armagh, are also not unfrequent. The Armagh limestone is overlaid by a reddish grit, which is another feature of resemblance. The direction of the dips, when observable, indicates a tolerable regularity in the line of the limestone, extending by Killylea to Tynan; but there is some variation in its characters, as compared with that of Armagh; the colour becomes darker; the fish remains though still abundant, are often broken, and not so varied in species, and some are probably peculiar to it. Chert nodules are associated with the limestone in the parish of Tynan, and it may be said, in general terms, that the limestone is nearer in character to that of Carnteel.

In the parishes of Aghaloo and Clonfeacle, the limestone is extensively developed, but does not rise into any prominent ridge. In the south-west corner of Sheet 67, at the quarries of Aghenis, it is more bold than usual, and the surfaces of the beds are very rough, from the large protuberances formed by corals in their ordinary growth. These are principally Lithodendra, but interstratified with the grey or slate coloured limestone, the white siliceous bed, two feet thick, already noticed in Derryloran, as entirely composed of Astræa *basaltiformis,* is again seen. It is remarkable, in respect to this coral, that, in the small openings here made, the tubes are parallel, and not perpendicular, to the beds, though all the other corals are in their true position of growth. The fossils of the limestone are all highly characteristic; the mountain limestone Trilobites of the genus Griffithides, large Productæ, Producta *granulosa*, Orthis *analoga,* Solemya *primæva* (Phillips), Sanguinolaria *oblonga.* The latter fossil and the approximate species, S. *sulcata,* and S. *maxima.* seem characteristic of the true lower mountain limestone; S. *sulcata* is thus seen in the beds overlying the principal fish beds in the Armagh limestone, in Derryloran, &c., and S. *maxima* in Donaghenry. In Lismulladown townland, near the top of the west line of Sheet 67, the limestone is grey and ochreous on weathering, is in beds varying from one to two feet in thickness, is more gritty than heretofore, and is shaly at the top; the line of strike is observed to bend round within the limited space of the quarry, the same character being preserved. All the limestone of this tract is considered inferior for burning, it occupies comparatively low ground, rising from flats amidst detritic hills of rounded form and uniform height. The limestone extends into, and occupies, the eastern side of Sheet 66, dipping generally to the westward, appearing in the same detached manner, and not rising to any marked elevation. It is here that the calcareous and fossiliferous grits of the upper section first appear in considerable development, and in difficult position; they have always been puzzling problems, and though stated by Mr. Griffith, in the Railway Report, to belong to the calp, have been coloured by him yellow sandstone. In this report, they are assumed to overlie the true lower limestone, and the low position of the limestone compared with the capping position of the grits, seems to confirm this view, though it may be sometimes doubtful whether the sandstone is not interposed between that limestone and another similar to, though geologically above it. This difficulty is experienced on passing the grit in a westerly direction when limestones and shales again occur. The latter might, indeed, be supposed to belong to the upper limestone, but in this comparatively low, though hilly country, there is no direct contact of the grits and limestones, the former having invariably a more elevated and capping character than the latter; hence, it is most probable that the surface of the associated limestones and shales has undulated over the whole space, or, which the appearance of the corals almost demonstrates, has been formed in parallel reefs or ridges. In this view, the series of shales seen at the north of Sheet 66, in Glendavagh, has a peculiar interest from its striking resemblance to the shales of Benburb; they are underlaid by the usual grey limestone, with the smaller species of Astræa, and lesser variety of Lithodendron *sociale* beautifully exposed on the cleavages in the natural order of their growth, whilst the shales contain Fenestellæ, and the beautiful Venus *elliptica*, variety *bi-striata*, found also at Benburb. It is very possible that these shales should be associated with the grits of the third section, as the shales, with ironstone nodules, grits, and impure limestones at Benburb, form an aggregate very different from the usual arrangement of the lower limestone, and more in accordance with the upper limestone shales of England. At Benburb, the aggregate is sufficiently marked to warrant a separation; but here the shales can only be considered sufficient to mark the boundary line of the two sections. Again, at the north-west corner of the sheet, tabular shale and impure limestone are exposed in the river bed, the shales containing abundance of the large Cyathophyllum *fungites*, from 14 to 18 inches long, and lying prostrate in the beds, as is usual with that species; also large Productæ. This aggregate strongly resembles that of the shales of Fermanagh and Sligo; but the actual value, as a geological constant of Cyathophyllum *fungites*, has not as yet been sufficiently tested to warrant the separation of these shales from the lower limestone, the shales of Bundoran exhibiting very similar appearances in their mode of arrangement, and in the abundance of Productæ: it is, however, worthy of remark, that this coral has not hitherto been found in the shales, which are, in this report, considered anterior to the lower limestone.

Passing into Sheets 60 and 61, and crossing the calcareous and fossiliferous grits, the limestones are again met in their full development, and rich in the most characteristic fossils, Astræa *basaltiformis*, Lithodendra, Syringopora, Trilobites, Nautilus *biangulatus*, whilst the appearance of the stone itself, and the general grouping of the same fossil forms, mark it out as belonging to the same section as the limestones of Derryloran and Desertcreat. In Carnteel, Ctenoptychius *macrodus* has been found; and in the adjacent parish of Clogher, Cochliodus *acutus*, and Petalodus *Hastingsii*, affording further proof of the sectional position of the limestone. The difficulty here is to understand the nature of the connection between the limestones, and fossiliferous grits which sometimes have the appearance of underlying them. This appearance is most probably illusory, and the sandstone is assumed to be the capping stratum, as the limestones occupy the lower grounds. An inspection of the dips of the limestone points out the irregularity of their arrangement, and their unconformability to the sandstones; and it is also evident from the map that, if the dips were alone consulted, the limestones would sometimes appear to dip under the old red sandstone. Amongst other reasons for considering the grits superior, geologically, to the limestones, is the presence of coal plants, and sometimes of coal, and their graduation downwards, not upwards, into highly calcareous and Productal beds, which contain also abundance of a minute Cypris. It would be useless to follow out, in similar detail, this section of the formation any farther, and indeed, without a comparison of its elements with the beds of Sligo, Leitrim, and western Fermanagh, the examination could not be made conclusive or satisfactory. The position of the limestone, in the parish of Clogher, is difficult; it occurs in a trough between the old red sandstone and the carboniferous grits, and whilst the position of the northern portion cannot be mistaken, the southern might be supposed to overlie a part of the sandstones; there is, however, evident disturbance of the limestone and shale strata, accompanied by the intrusion of dykes, and the sandstone appears at the north point of the section to cap the limestones which have probably been thrown up by elevation, although it acquires an augmented dip on approaching the axis of the hill, where shales and limestones are again observed in positions which indicate that they underlie the sandstones. Shales containing Orthis *filiaria*, Bellerophon *Urii,* Cidaris *Benburbensis,* &c., are associated with the sandstones; they therefore resemble the beds which overlie the limestone of Cullion, in Derry. These appearances it has been endeavoured to represent in Pl. G., figs. 4, 5. In the Donegal and Fermanagh section, a similar difficulty occurs in understanding the relation of the limestones of Pettigo and Kesh with the topographically intervening grits and shales. As before observed, the lower limestone of this section approximates to that of Bristol in its dark colour, is broken up at its base by shales; the fossils are the large characteristic Productæ, Astræa, &c., and in addition to them, in the class Pisces, Helodus *turgidus.* This limestone is evidently continuous by Belleek to Bundoran, where Petalodus *rectus* has been found, and it is further assimilated to that of Bristol by the dolomitic character of some of its beds. Throughout the whole of this line, the limestone appears to be followed, in geological succession, by highly calcareous grits, graduating into limestones, and containing plants, amongst which is Stigmaria *ficoides*, and coal occasionally. The fossils are marine, some common to the limestones, as Producta, and others characteristic, as the Pecten *semicostatus* and P. *ottonis?* (Pl. XXXVI., figs. 9, 10), Spirifera *laxa,* (Pl. XXXVII., fig. 6), and the remarkable shell, figured and described as Cypricardia *tricostata.* This highly fossiliferous character is confined to the limestone-like portion of the beds, and affords a striking proof of the identity of the same description of rock in Fermanagh and in Tyrone parish of Carnteel, so that, whatever position is assigned to the one, be it the yellow sandstone, the calp, or the millstone grit, the same must be assigned to the other; and this rule applies to the sandstone of Bannagh, of Boa Island, of Bundoran, and probably of Derrygonnelly, although very different positions have been assigned to them.

Separated geographically from the Pettigo beds by the grits, limestone and shale again appear at Crevenish, near Kesh, and thence cross the county to Ederny. It is low, and on the side of the lake displays a most beautiful spectacle in the various corals, Lithodendra, Syringopora, and Astræa, which cover the face of the rock in all the profusion of their natural growth;

topographically, there is a considerable distance between this limestone and the supposed overlying grits, and a proof of disturbance and probable elevation is obtained in the condition of the nearest grits on the lake, which dip away from the limestones in a direction quite different from their usual dip: provisionally, therefore, this limestone is assumed to be a re-appearance of that of Pettigo.

The difficulty which has been pointed out in determining the relations of the limestones in isolated and distant positions to the calcareous grits, is equally felt as regards the upper limestone, or the limestone which forms the upper member of the upper limestone shales of Conybeare and Buckland, in a district where there is no exposed section. As, however, the calcareous grits disappear in an easterly direction, it is very possible that the limestone of Donaghmore and Drumglass may be thus brought into immediate succession to the lower limestone; and as there is a considerable difference between the aspect of the strata there and in the Derryloran system, it is very possible that they do belong to the upper section. Between the limestone of Drumglass and that of Donaghmore, it does not appear possible to draw a line of separation, as the great mass of the beds in one corresponds to that of the other, although a particular fossiliferous bed may be observed in one which does not occur in the other.

This limestone may in general terms be stated as smooth, close grained, hard, and splintery, of various tints of slate colour, and weathering ferruginous, and gritty; some of the beds are nearly a shaly calcareous sandstone, and in Donaghmore the smooth even beds of limestone are separated by thin layers of shale, crowded with the Cypris figured in Plate XXIV. The fossils in the hard limestone are usually rare, or do not become visible till weathered; but in softer or more shaly beds they are abundant; in the Drumglass quarries, they are peculiarly so, and form a group, distinguished by Fenestella *irregularis*, Glauconome *pluma*, var. Vincularia, Pecten *interstitialis*, Producta *sulcata*, &c.; but this highly fossiliferous bed is associated with others which cannot be distinguished from those of Donaghmore and Castle Caulfield, nor can its true value be determined from so limited a space. The Glauconome, here so common, has the form of G. *bi-pinnata*, and the *projecting* pores of G. *pluma*. The occurrence of the genus here, and at Benburb, and also of Favosites, in a position so high in the system, is remarkable.

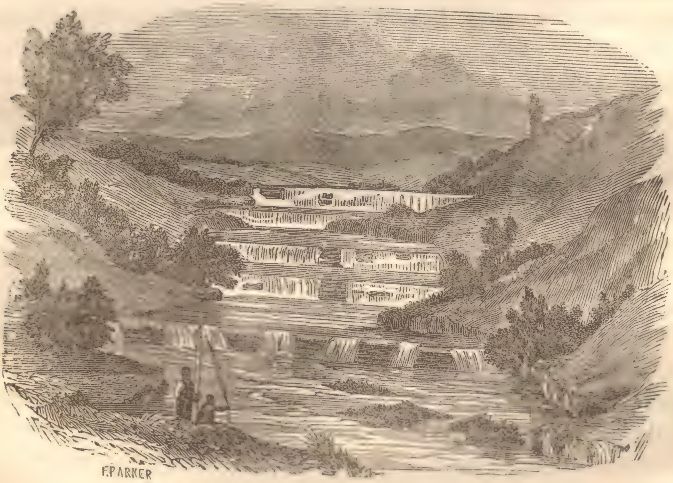
In the preceding remarks, a general review has been taken of the reasons for believing that there is a lower section of the carboniferous system, varying from the type of Professor Phillips' transition member to that of the lower limestone shales of Conybeare and Buckland; that this is followed by a highly developed limestone; that fossiliferous and calcareous grits succeed, which are possibly anterior to another deposit of limestone, corresponding to the upper limestone of the upper limestone shales of England. The various shales and calcareous grits presumed to be anterior or posterior to the lower limestone, will now be comparatively considered.

South of the Cullion limestone (see Plate E., fig. 7), grits, shales, and shaly clays succeed in geological order. In the grits, portions of Stigmaria are found; and in the shales, an abundance of fossils, including minute Orthoceræ, Bellerophon *Urii*, Spirifera *bisulcata*, Orthis *filiaria*, Nucula *tumida*, the locality, in respect to the last two, singularly corresponding to the upper limestone shales of Scotland. Beds exactly agreeing with these do not occur within the district; but at Benburb, Orthis *filiaria* again appears, as also in the shales associated with the grits of Clogher, Bellerophon *Urii* being also there present. Leaving aside the shales subordinate to the limestones, the following variations of type may be noticed, and clearly indicate how limited the distribution of fossils frequently is, and how readily the character of a formation might be modified by a local variation in its mineral beds, or in the grouping of its fossils. North of Ballygawley, a patch of shales is observed, associated with hard calcareous bands: in position it is obscure, but it is evidently underlaid by a spit of the old red sandstone (which is there much disturbed, its dip being altered to the southward), and as evidently underlies the adjacent limestones. Some of the layers of this shale are thickly covered with Pecten *plicatus*, some varieties of which approach to P. *transversus*, whilst other layers are equally covered by a faintly-marked Sanguinolaria: this is a group as yet noticed in no other locality, and is here considered another type of the lower shales, as it includes neither corals, Productæ, or Spiriferæ of the mountain limestone.

In Sheet 59, south of Clogher demesne, the two classes of shale are nearly in contact, the lower studded with Modiolæ, and the limestone shales covered with Fenestella *flabellata*. In the latter are Productæ (few), P. *pustulosa*, and Serpula *socialis*, by which the group is individualized, as that fossil has not yet been found elsewhere. In Sheet 64, near its eastern margin, shales overlie the limestones, and are distinguished by containing Goniatites,

(Goniatites *granosus*, &c.), which appears to be a fossil genus of more limited range than is usually supposed; at this point, the limestones and shales dip towards the great mass of grits, and it is, therefore, easy to understand that they are here underlying them, the shales being probably subordinate to the limestone. In the overlying grits, shales are interstratified, which contain characteristic fossils, amongst which were specially noticed Orthis *filiaria*, Bellerophon *Urii*, and B. *striatus* (Flem.), fossils connecting the deposit with that at Cullion. At the southern base of the grits, shales and impure limestones also occur, and as none of the fossils corresponding to the true lower shales have been yet found, they appear to be distinctly carboniferous, but whether they should be classed with the true lower limestone, or put below them, is doubtful; it is in these shales that the Gorgonia, so closely resembling the silurian species, is found. In the lowest layer of the grits is a shale having the impression of a Sphenopteris *linearis* (Pl. XXXVIII., fig. 7); and this curious association of beds, rich in vegetable fossils, with others equally rich in marine fossils, seems a natural succession to the reef-like arrangement of the coralline and Productal limestones. In Fermanagh, similar variations in the typical grouping occur. In the river, near Tempo, a smooth clay-like shale is spangled with minute scales of Palæoniscus, and contains also impressions of the scales of Holoptychius *Portlockii*, mixed with Lingula *squamiformis* and Pterinea *Thompsoni*; this, then, is a perfectly local group, occupying a low topographical position, which renders the geological determination difficult. It is for the present considered above the lower limestone. In the north of Fermanagh, the shales, so finely developed on the Bannagh River, and again between it and the Pettigo limestone, are extremely difficult of sectional identification, from the obscure manner in which their relations are made out with the overlying grits. The occurrence also of Modiolæ shales, in immediate connection with others, rich in characteristic carboniferous fossils, increases the difficulty. It is probable that the Modiolæ shales underlie the whole system, but it is impossible, in the present district, to determine it as a fact; and in like manner it is highly probable that the carboniferous shales underlie, geologically, all the grits up to the Pettigo limestone, but this also cannot be demonstrated; hence, no more has been attempted on the section (Plate G., fig. 6), than appears warranted by the visible data. In the Bannagh River, the shales are observed to curve over and form a swelling knoll, underlying the sandstone on both sides of the river, and there is reason, therefore, to believe that they are a continuation of the more northern shale, as represented in the section; but the latter cannot, with equal certainty, be said to underlie the highly calcareous grit, which immediately rests on the Pettigo limestone. Provisionally, therefore, it has been necessary to associate these shales with the grits in the third section, or upper limestone shales and grits of England. The carboniferous group, on the Bannagh, is peculiar to the locality, including teeth of Holoptychius, scales of Palæoniscus *Egertoni?*, spines of Trystichius *minor* associated with a fragment of Psammodus *cornutus*, and Chomatodus *linearis*. The plants are also peculiar; they appear like very long, narrow, linear leaves, carinated, and obscurely veined, confusedly mixed together, no stem having been yet discovered; they strongly resemble the leaves of Sigillaria *Lepidodendrifolia* (Brong.) Some of the layers also are thickly covered with Cypris. The shales are arranged in the tabular manner which is so striking on the opposite side of Lough Erne, and the river passes in falls over the successive steps of the strata, as exhibited in the woodcut.

No. 24.



One locality of the shales should be here more particularly noticed, namely, that at the north-west corner of Sheet 60 (Tyrone), where fossil plants are abundant—Stigmaria and Sigillaria? In the Maghera section, plants were also abundant; but there appears to be here a variation of the type, and a greater approximation to the true carboniferous strata : it is probable, therefore, that, though resting on the old red sandstone, this partial deposit may be higher in geological position than the true lower shales.

This brief review of the shales can only convey a faint idea of their local peculiarities ; but it is sufficient to warrant a belief that, just as the lower shales are distinguished by the abundance of Modiolæ, so some of these beds are not merely local variations, but distinct members of the system, occurring here in too detached and independent a manner to be arranged in regular sequence, but which hereafter may be so arranged, on comparison with a more defined section.

With respect to the carboniferous grits, it is unnecessary to refer again to those of Derry, which are presumed to underlie the lower limestone, or to the grit associated with shales and overlying the limestone at Cullion, as it is almost demonstrable that they correspond, the first to the transition member of Professor Phillips or to the lower limestone shales and grits of Conybeare and Buckland, the second to the shales and grits of the upper limestone shales of Conybeare and Phillips, the grits here containing Stigmaria. Passing into Tyrone, the patch in Tullyniskan, represented "yellow sandstone" on Mr. Griffith's map, is considered a portion of the coal series, as it appears too intimately connected with the sandstones in Farlough where an outcrop of the coal was observed, to be separated from them, and although their dip may produce an appearance of underlying the older limestone, they are not conformable to it, and have a similar appearance of overlying the limestone more to the south. In general appearance, they strongly resemble the true carboniferous grits. The great development of the grits, beginning south of Dungannon, and passing through Clonfeacle, Carnteel, Aghaloo, and Clogher, where it obtains its greatest expansion, has been already noticed ; they have throughout a striking character of resemblance, varying from pure white to various ochreous tints, and being frequently much cribbled by the removal of calcareous matter and oxide of iron, with the latter of which they are often speckled and stained. Remains of plants are common, and coal is occasionally found in thin seams. At their base, they are sometimes found to graduate downwards into a calcareous bed, containing Productæ, and sometimes are associated with shales containing distinctive carboniferous fossils. These reasons, as well as their usual overlying position and relations to the true lower limestone, have been considered sufficient to warrant their removal from the lower section of the system, or the yellow sandstone, to the middle section or the calp of Mr. Griffith, a view further supported by the recent change made by Mr. Griffith in the position of the Fermanagh grits, which, in every respect, possess the same characters. As a remarkable instance of this correspondence in character, may be mentioned the occurrence, in Carnteel, of the same highly calcareous and splintery grit, containing the remarkable shell which has been figured and described as Cypricardia *tricostata*, a doubtful genus, but a most distinct shell: Pectens (Plate XXXVI.) are also abundant in some of the beds, and serve farther to identify them; they can be traced in Fermanagh, where they overlie the Pettigo limestone, from Formil by Boa Island across the lake to the grits overlying the shales and limestones of Bundoran; and in a similar manner they are observed at Derrygonnelly and Monea. The grits below Formil contain Calamites, *Stigmaria*, and *coal*. The difficulty usually felt is to determine whether these grits do or do not overlie the limestones; but as they usually, when near the limestones, occupy overlying positions, whilst the limestones, disturbed and dipping in various directions, appear in comparatively low positions, it is here believed most probable that the limestone is the underlying rock, developed more frequently as distinct ridges or reefs, and subsequently covered by the grits: when represented as sandstones, and separated, as is here done, from the limestones, they become most interesting members of the carboniferous formation, those of Fermanagh assisting to elucidate those of Tyrone, though much is yet necessary to enable a correct estimate to be formed of their actual position in a great section of the whole formation.

In speaking of the limestones, it has already been said, that a striking individuality can sometimes be traced in a particular bed over a very extensive space, though, from the broken and detached character of the deposits, it may be impossible to decide how far it was once continuous: the white siliceous layer, filled with Astræa *basaltiformis*, has been noticed as one of these; but there is another even more striking, and remarkable from the abundance of Gasteropoda and Heteropoda it contains. This limestone is gritty, full of cavities, which are lined with carbonate of lime, and is very ochreous on weathering, the fossils being usually stained with oxide of iron. It is the great bed for Cirrus *Dionysii*, and Bellerophon *apertus*, and contains, also in one locality, Nautilus *multicarinatus*. There is a peculiarity in this bed which admits of its recognition in several localities both in Tyrone and Fermanagh, and it will probably hereafter afford a clue to the true position of other beds connected with it in a great section of the whole formation; it strongly resembles in character and fossils the Scotch limestone.

By combining the consideration of the mineral and fossil characters of rocks, many other examples would be discovered of an identity of deposit in distant localities. Amongst some valuable Berwick fossils, obligingly sent me by the Rev. Mr. Jenkinson, of Lowick, I find both the species (figured Plate XXXIV., figs. 20, 21) Sanguinolaria *undata* and S. *transversa*. The specimens are perfect, and show that S. *undata* was nearly identical in form with S. *transversa*, but distinguished by the angular folds of the posterior portion of the shell (page 434). The principal Fermanagh locality of S. *transversa* is a smooth calcareous grit; and though the Berwick rock is less siliceous, it strongly resembles it, and thus connects the shale bed of Tyrone containing S. *undata*, the Fermanagh beds containing S. *transversa*, and the Berwick bed. It is another example of a correspondence in type, of the carboniferous formation in Great Britain and Ireland, and proves that the *whole* of the formation must be compared with the *whole* in England and Scotland, and not the upper limestone of Ireland alone.

In pursuing this investigation it has been necessary to leave the narrow limits of Derry and of the Barony of Dungannon, and to seek illustrative facts in western Tyrone and Fermanagh; to remove all difficulties and to establish on a solid foundation the subdivisions of the carboniferous strata, the inquiry should be carried still farther into Fermanagh and Donegal, and into the counties of Leitrim and Sligo, but space will not allow of further dwelling on this interesting and important part of the subject, and what has been here said must be merely considered the opening of a most difficult and intricate research. Before closing the chapter, a view will be taken of the upper portion of the system, or the distinctly developed coal field.

DESCRIPTIVE ACCOUNT OF THE COLLIERIES OF THE COUNTY OF TYRONE.

In order to render this portion of my Report more generally useful and interesting, I shall not confine myself to a simple statement of the practical results obtained by working the coal, but also give such descriptions of the mode of working as will, in some degree, render the subject familiar to every class of readers. In doing this, I have thought it best to obtain from the persons directing those establishments such information as they could give consistently with their duty, and to publish it, as nearly as possible, in their own words, and then to add my own remarks on such parts as appear to require further elucidation, or which suggest useful practical observations. To my inquiries I have received the most ready and comprehensive replies, and of these I shall first cite the copious and interesting account of the Annagher Colliery furnished by Richard Griffith, Esq., whose name it is only necessary to mention to prove the value of his communication.

Coal Island Collieries.

2, Fitzwilliam Place, Dublin, November 12, 1842.

In reply to your request that I would supply you with information regarding the present workings, &c., at the Coal Island Collieries, I beg to state that the works are now, and have been for some years, confined within the limits of the lands of Annagher, situate at the northern extremity of the Tyrone coal district, and on the confines of the new red sandstone and tertiary clay districts of Lough Neagh.

In my report and section of the Tyrone collieries, published by the Royal Dublin Society in the year 1829, the position of the strata of the lands of Annagher, situated to the north of the village of Coal Island, as compared with those of Derry and Gortnaskea, situated to the south of it, are carefully laid down, I need not therefore enter on the subject further than to state that in the recent shafts that have been sunk in the lands of Annagher, the several beds of coal shown in the section as occurring there have been ascertained to exist, and all have been worked to a considerable extent within the last few years.

The coal measures of the northern extremity of the lands of

Annagher, within the boundaries of the overlying new red sandstone, dip north-east, at angles varying from 20° to 25°. Within the last five years, two principal shafts have been sunk, one on the *dip*, called No. 1, to the depth of 124 yards, and the other, called No. 2, on the *rise* of the beds, 180 yards from it, to the depth of 106 yards; and, nearly midway between them, there is faulty ground, in which no coal occurs for a space of 30 yards in breadth.

For the sake of clearness, I shall here insert a table of the strata sunk through in each pit, and afterwards describe any peculiarities of importance observed.

Table of the strata passed through in Shaft No. 1.

	Yds.	ft.	in.	Yds.	ft.	in.
Surface, consisting partly of a clayey mass, including boulder stones, and partly of siliceous sand	14	0	0			
Alternating beds of fine grained red sandstone and red shale, belonging to the new red sandstone	76	0	0			
Red quartzose sandstone, very hard	1	0	0			
Red shale	1	0	0			
Grey compact quartzose rock	1	0	0			
Alternating layers of yellow and grey claystone	2	0	0			
Black shale, coal roof	0	1	0			
First Coal, called crow coal	0	2	0			
				96	0	0
Grey fire-clay	1	0	0			
Grey sandstone-slate, alternating with grey compact sandstone	16	0	0			
Dark grey compact claystone	1	0	0			
Greyish-white claystone	3	0	0			
Light grey claystone in thin beds, with coal partings	2	0	0			
Second Coal, Annagher coal	3	0	0			
				122	0	0
Grey fire-clay, not penetrated				2	0	0
				124	0	0

Table of the strata passed through in Shaft No. 2 *to the rise of Shaft No.* 1.

Surface soil, gravel, and sand	24	0	0			
Red clay	2	0	0			
Greyish-white claystone	3	0	0			
Hard black sandstone-slate	4	0	0			
Greyish-white claystone	1	1	0			
First Coal, called crow coal	0	2	0			
				35	0	0
Grey fire-clay	1	0	0			
Dark grey shale	3	0	0			
Grey sandstone-slate	2	0	0			
Hard grey sandstone	1	0	0			
Grey sandstone-slate	2	0	0			

	Yds.	ft.	in.	Yds.	ft.	in.
Grey claystone in thin beds	2	0	0			
Second Coal, or Annagher coal	2	1	6			
				48	1	6
Grey fire-clay	2	1	6			
Dark grey sandstone-slate	7	0	0			
Greyish-white claystone	1	1	6			
Grey sandstone-slate	1	0	0			
Third Coal, called bone coal . . .	1	0	0			
				61	1	6
Fire-clay	1	2	6			
Dark grey sandstone-slate	1	2	0			
Grey sandstone-slate, with casts of Sigillaria *organum*	1	0	0			
Grey sandstone-slate	4	1	0			
Grey claystone	3	0	0			
Dark grey shale	0	1	6			
Grey sandstone-slate, hard	0	1	0			
Fourth Coal, called the shining seam . .	0	2	6			
				75	0	0
Grey fire-clay	2	0	0			
Grey sandstone-slate	3	1	0			
Dark grey shale, containing casts of shells (Unio *acutus*)	0	1	0			
Grey sandstone-slate, with Calamites, &c. .	1	1	0			
White sandstone, fine grained . . .	3	0	0			
Grey sandstone-slate	5	1	6			
Bluish-grey claystone	8	1	6			
Bluish-white claystone	3	0	0			
Black shale	0	1	0			
Fifth Coal, called five-foot coal . . .	1	2	0			
				104	0	0
Fire-clay				2	0	0
				106	0	0

It appears from the foregoing detail of the strata sunk through in pits No. 1 and No. 2, that in No. 1 the true coal measures are covered by 76 yards of strata, consisting of alternations of fine-grained red sandstone and red shale. These beds belong to the new red sandstone, and probably to the lower portion of the series. I am unable to speak positively as to whether or not the red strata lie conformably on the coal measures; the dip of both is towards the same point, with about the same angle of inclination; and the pitmen, who were directed to ascertain the fact, think they are conformable. If they be, it must be an accidental circumstance, as the new red sandstone is an overlying series, and rests equally on the coal measures, and on the subjacent carboniferous limestone.

Beneath the red beds the coal measures at once present a different character and colour, and the series, as may be seen by reference to the table, consist of alternations of grey sandstone-slate and greyish-white claystone, with occasional beds of a darker tint; but, on the whole, the colour of the coal measures, as exhibited in the pit heaps, is much lighter than that usually presented at other collieries, the average tint being bluish-white, passing into grey; and the beds taken as a whole, are very soft, and quickly fall into clay when exposed to the air.

In every instance the beds of coal rest on a stratum of light grey fire-clay, which is very soft, and consequently forms a bad floor for the coal workings, as will be mentioned hereafter. This fire-clay is much used in the manufacture of fire bricks and fire tiles, both of which are of excellent quality, and equal to any imported from England or Scotland.

By reference to the succession of strata passed through in shafts Nos. 1 and 2, above the Annagher or nine feet coal, it would appear that the strata interposed between the same beds of coal are in the two shafts variable in thickness, and not identical in composition. Thus, if we look to the strata interposed between the crow coal and the nine feet coal in shaft No. 1, we find that they amount in thickness to 23 yards, while in shaft No. 2 the nine feet coal is only 11 yards beneath the crow coal, making a difference of 12 yards, and this difference consists chiefly in the thickening, to that amount, of the strata of sandstone-slate in shaft No. 1.

Of the Fossil Remains which occur in the Coal Measures at Annagher Colliery.

In this locality the fossils are not numerous; they all appear to belong to the upper coal series, and no organic remains of a marine character have hitherto been collected by me from the coal measures to the *north* of Coal Island.

The surface being concealed from view by a covering of detrital matter, varying from 16 to 30 yards in thickness, no part of the solid strata has ever been seen, except that raised from the shafts, each four feet square, and consequently within such narrow limits, we cannot expect to find any great number or variety of fossil remains.

In pit No. 1 casts of Sigillaria *organum*, Sigillaria *pachyderma*, and Calamites *nodosus*, of Lindley and Hutton, have been collected from the grey claystone above the second or nine feet bed of coal.

In pit No. 2, two varieties of Sphenopteris have been obtained from the claystone interposed between the third or bone coal, and the fourth or shining seam; one of these, Sphenopteris *Hibberti*, is figured in Lindley and Hutton. These beds also contain beautiful casts of a

Lepidodendron, much resembling Lepidodendron *elegans*, but not identical with it; also, Pinnularia *capillacea*, Sphenophyllum *erosum*, and several imperfect casts of Calamites.

The argillaceous ironstone, which occasionally occurs in the shales and claystones, also contains casts of Calamites *nodosus*, together with Neuropteris *acuminata* and Neuropteris *gigantea*; and the dark grey shale, five yards below the fourth bed of coal or shining seam, contains numerous casts of Unio *acutus*.

By reference to the section of the strata passed through in pit No. 2, it appears that five beds of coal occur within the depth of 104 yards from the surface, namely:—

	Thickness.			Depth beneath the surface.		
	Yds.	ft.	in.	Yds.	ft.	in.
1, Crow coal	0	2	0	35	0	0
2, Annagher coal, usually 9 feet thick, but in this pit only	2	1	6	48	1	6
3, Bone coal	1	0	0	61	1	6
4, Shining seam	0	2	6	75	0	0
5, Five feet coal, or main coal . . .	1	2	0	104	0	0

In other parts of the district different beds of coal have been sunk to and worked, and at Annagher, I know that at the depth of about 22 yards beneath the five feet coal, there is an impure sulphureous bed, called the Baltiboy coal, which varies from nine inches to three feet in thickness, and which I believe to be the lowest bed which occurs in the northern part of the district. This is chiefly proved from the result of several trials, by sinking and boring, which were made, within the last twenty years, by different mining companies, through the strata which lie beneath the Baltiboy coal where they crop out to the surface, beyond its outgoing, particularly in the School lands. In these trials the strata were found to consist of alternations of dark grey shales and sandstones, to the depth of upwards of 90 yards, without the occurrence of any bed of coal; and as the subjacent carboniferous limestone appears at the surface in the lands of Lisnastrane, within a short distance to the rise of the deepest borehole, it is probable that no workable bed of coal exists between it and the Baltiboy coal.

The quality of the different beds of coal in the neighbourhood of Coal Island is nearly the same; they are all easily ignited, flame briskly, and burn swiftly, leaving a considerable residuum of white or greyish-white ashes. The large coal only is applicable to domestic purposes, and the small, which is altogether used for burning lime and bricks, is drawn from the colliery by land carriage, to distances varying from 15 to 20 miles. The large screened coal is sold at the rate of 13*s*. 4*d*.

per ton of 20 cwt., and the small, at rates varying according to quality, from 5*s.* to 8*s.* 4*d.* per ton. The greater part of both the large and small coal is consumed within the neighbouring district, but a portion, say about one-sixth, is shipped on board lighters on the Coal Island Canal, and transported across Lough Neagh to Portadown, Randalstown, Ballyronan, and other ports on the Lough.

The quantity of coal sold at Annagher Colliery, including large and small, during the years 1840 and 1841, amounted to 19,154 tons, of which 3081 tons were large coal, and 16,073 tons small; the whole produced £7,500 14*s.*, making an average of nearly 7*s.* 10*d.* per ton.

The number of persons employed under ground, including coal cutters, hurriers, and boys during the above years, amounted on an average to 50 per day, and the surface labourers to 27.

System of working adopted at Coal Island Colliery.

Owing to the softness of the strata which accompany the coal of this district, considerable difficulty has been experienced in keeping open the shafts, as well as the workings in the different beds of coal.

In regard to the shafts, after many trials, it was ascertained that the least expensive system was to sink two parallel pits, each four feet square, at the distance of four feet from each other, and to secure each from the top to the bottom by the insertion of strong square frames of timber placed at the distance of two feet from centre to centre, and afterwards connecting the whole by a series of sheeting boards nailed to each of the square frames. In many cases circular pits four feet in diameter were sunk, and lined from top to bottom with regularly sommered fire brick; but, owing to the softness of the strata, particularly the claystones, these brick shafts, after some time, were found to twist, and bend out of the perpendicular in certain parts, and great difficulty was experienced in repairing and rendering them plumb; whilst in the timbered shafts, by the removal of a few frames of timber and the insertion of others at the points of derangement, the difficulty was quickly overcome at a trifling expense.

In the underground workings, the system followed is what is technically termed the *narrow way.* First, from the bottom of each of the shafts, passages six feet wide and of the height of the coal are cut in opposite directions on the level of the bed for the length of seven yards; next, similar passages, called upsets, are cut at right angles to the level, to the rise of the coal for a distance of twelve yards, at the end of which the pitmen in both excavations turn towards each other and work on the level of the coal till they meet, which they will do when each has cut eight yards from the upset. This communication being effected, a free circulation of air will pass down one of the shafts, round the working, and up the other. This completes the first or preliminary working, called forming the *turn pillar*.

The next operation consists in employing coal cutters to continue the main or lower level in opposite directions, while others are employed in continuing the upper level, which is called the counter-level, from the ends of the upsets, at the distance of twelve yards from the lower level. These excavations are continued till each coal cutter has opened his level twelve yards from the first upsets, when the main and counter-levels are again connected by second upsets, and by this means pillars of coal twelve yards square are formed and left to support the roof.

In continuing the work the same system is pursued, the main and counter-levels connected by upsets being carried on for an indefinite length as circumstances, and particularly the soft and tender nature of the roof and floor, will admit of. While these main or lower workings are in progress, a second, third, and fourth system of similar levels and upsets are carried on, so as to divide the whole of the coal within command of the pit into squares, leaving pillars, each of twelve yards, between the several upsets.

In No. 2 pit, at Annagher Colliery, the workings have been hitherto confined to the lowest or five feet coal: in it the main level has been extended to the length of 190 yards to the *north*, and 260 yards to the *south*, while the principal upsets have attained the length of 124 yards.

Much difficulty has been experienced in this, as well as in the other collieries of the immediate neighbourhood, in keeping open the several excavations, owing to the soft and incoherent nature of the strata which lie below and immediately above the coal, and which, when even slightly wet, quickly assume the pulpy appearance of ordinary brick clay. The system adopted is to support the roof by the insertion of timber frames at distances, according to circumstances, of from two to four feet between each. These frames consist of uprights of native timber, usually from six to eight inches in diameter, or sawed timber eight or ten inches by four, called puncheons, placed in an upright position on each side of the level or upset, and connected at top by a cross piece, usually of smaller dimensions, called the lid, the top of each puncheon being notched, so as to receive the rounded surface of the lid.

In the main level smaller pieces of timber, called splits, are inserted longitudinally along the roof, and rest on the lids, and thus the whole working is supported *in a temporary manner*: I say temporary, for, owing to the want of tenacity in the fire-clay which forms the floor, it soon swells and heaves up, frequently bending and breaking the puncheons, and if they be strong enough to resist the pressure, they are forced down through the floor, which frequently swells up in one night so as nearly to close the passage. When this happens the floor is cut away, drawn to the pit bottom, and sent to the surface, and new puncheons and lids are inserted.

Notwithstanding these difficulties, to diminish the expense of carriage of coal underground, railways, made of bars of wrought iron, have been laid in the main levels, but daily repairs are required to preserve them even in tolerable order.

When the whole of the coal within command of the shaft has been divided into squares, by levels and upsets as already described, the removal of the pillars becomes the next operation.

This is effected, commencing with the pillar farthest from the shaft, by cutting passages six feet broad through the centre, both on the level and to the rise. By this means every pillar is divided into four, each five yards square, which are again reduced by cutting passages along the sides of the old excavations, and filling up the vacant spaces with any portion of the roof which may fall, and thus proceeding cautiously and gradually, and still supporting the works with puncheons and lids, the whole or nearly the whole of the pillars throughout the working may be removed, with the exception of that first made, which supports the bottom of the shaft, and which is preserved with care till the work is about to be abandoned.

Fortunately very little water has been encountered in the Annagher Colliery. Had there been much, no expense of timber could have sufficed to support the excavations, and even under the present favorable circumstances, the cost of prop timber absorbs a large portion of the sales.

The coal is raised through the shafts by horse gins; steam power has not been resorted to on account of the expense, as, owing to the difficulties already enumerated, no working sufficiently extensive to require a steam-engine can be kept open at one pit; and no care or expense can preserve the levels for more than two years. Under such circumstances the cost of erecting engine-houses, steam-engines, and setting up pumps every two years, would be much more expensive in the aggregate than employing six horses every twenty-four hours at each pit, which number has been hitherto found sufficient to raise all the coal and water from a shaft 106 yards in depth.

I have confined these observations to the operations of the Annagher or Coal Island Collieries, which are carried on under my general direction. The system followed is, in many respects, peculiar to the locality, and has been found to answer, and make a small return to the proprietors; while, within the last few years, the same beds of coal worked by us, were also worked on the adjoining lands by the Hibernian Mining Company, who erected a powerful steam-engine, and conducted the under ground workings in a less cautious manner than that above described, and in consequence there has been a great expenditure, but no commensurate return.

RICHARD GRIFFITH.

To the description which Mr. Griffith has so kindly contributed, little remains to be added from my own personal observation. The general aspect of the establishment is rude and unfavorable, as there is no air of finish, nor any of those applications of mechanical contrivance which confer elegance on the most common operations. The buildings are very limited. The coal is raised in a large barrel, containing five cwt., which is suspended on swivels, and being caught on its ascent at the mouth of the pit, is turned over and emptied successively into two large barrows, each containing two and a half cwt., which are then wheeled off to the screen. As there is very little water, both shafts, on ordinary occasions, can be used for raising the coal, one barrel ascending in the one as the second descends in the other. The shaft in wet weather is leaky, the water springing from the sides and falling on the descending visitor like a shower of rain, but the levels are perfectly dry. The bad quality of the roof, mentioned by Mr. Griffith, renders it difficult to support, and in consequence the roofing timbers are very much bent, and, in like manner, the swelling of the floor has doubtless much diminished the original height of the levels, which are now about five feet, with a width of four feet. The rails laid down in the working level appear, however, at present, to preserve their position tolerably well. In the upset I visited, I found the miner working in a space six feet wide, by two feet six inches high. The ventilation is sufficient in the portion I saw, as the air was perfectly fresh. In expressing the feeling which naturally arises in the mind of a visitor of this establishment, I do not lose sight of Mr. Griffith's comparative reference to the neighbouring collieries formerly worked by the Hibernian Mining Company on the same seams, but now abandoned. The local managers of the affairs of that company most certainly erred in an opposite direction; they erected buildings suited to a very extensive establishment, and they put up powerful machinery, as if they contemplated an unlimited supply of coal, and a constantly augmenting demand; no steps were, however, taken to produce an increased demand; the seams, which are regular in Mr. Griffith's mine, are here irregular and uncertain, and the expenses of raising a limited quantity of coal increasing as the works progressed, the profits diminished, till becoming inadequate to the support of the works, they were abandoned. In Mr. Griffith's establishment, where the seams are regular, economy is strictly attended to; and though carried so far as to produce an air of meagre rudeness, has been effectual in realizing a profit; the pecuniary balance is therefore in favor of the system, as compared to that of the Hibernian Company. But though this must be allowed, can it be doubted that a medium between the two systems would be the right one, and that the principle applied to all other collieries is equally applicable to this, namely, that profits should be made by low prices, with increased consumption. It is stated by Mr. Griffith that the coal is sent to a distance of twenty miles, and this very fact proves that the few straggling carts which now come so great a distance, might be replaced by ten times the number, if the proprietors adopted the principle of forming depôts for their coal at all the chief towns within a reasonable distance, and then contracted for its transmission to them. A moderate addition to the price would repay the cost of transport, and the coal would be used by hundreds or thousands of persons, when found at their doors, who would never think of sending for it, or perhaps have no means of doing so. This subject will be again resumed in reference to the Drumglass Colliery, and it is therefore only necessary to add here, that the fear of working out a colliery is no good reason for starving the supply. Bring the coal to the doors of the consumer, who has yet to learn its use, and when he has done so, he will encourage its importation and transmission from other countries, even should the home supply fail him. Let not the philosopher be afraid of creating a new appetite for coals, as on a principle of common prudence, it is more desirable to possess that appetite now, when coals can be procured at a reasonable price, than at a future period, when the price will necessarily be much augmented; it should be said, therefore, use coal now; cultivate the tops, and preserve the bottoms of the bogs for a future day.

In reference to the interesting observations of Mr. Griffith on the remarkable difference in the thickness and composition of the strata occurring between the crow coal and the nine feet coal in the two shafts, though only 180 yards distant from each other, it will be instructive to compare the two sections more closely.

1. In pit No. 1 there are sixteen yards of grey sandstone-slate alternating with grey compact sandstone, immediately below the underlying grey fire-clay and between it and a series of claystones, the total thickness between the crow coal and the Annagher or "nine feet" coal being twenty-three yards.

2. In pit No. 2, if three yards of dark grey shale be included, there are also sixteen yards of grey sandstone-slate and grey sandstone between the crow and *bone* coals, the total distance between them being twenty-six and a half yards, or only three and a half yards more than that between the crow and Annagher coals in No. 1.

3. The thickness of the Annagher coal in No. 1 is three yards; the united thickness of the Annagher and bone coals in No. 2 three and a half yards. Can it then be possible that the two seams of pit No. 2 are united into one in pit No. 1?

Plate H., fig. 2, is a plan of the workings from pit No. 2, contributed by Mr. Griffith, but no general plan of the whole workings has been kept. Plate G., fig. 5, is a sectional view of the seams, showing the troubled or faulty ground and the downthrow of the coal.

Collieries of the Hibernian Mining Company.

It is much to be regretted that the records kept both by this company, and the private company managed by Mr. Griffith, are deficient, more especially in a proper plan of the workings, in the Coal Island district; and as this deficiency cannot now be supplied, the actual underground condition of the seams must remain unknown. Mr. Sinclair, the present viewer at the new Drumglass Pit, joined the establishment too late to remedy the evil, or to supply much additional information on the district. He was personally acquainted with the Bartley Pits alone, and that only for a short time, as his own remarks will explain.

Bartley Pits.

"The only pits which I have had an opportunity of examining, besides the Lewin Pits, are some sunk on the School Lands, near Coal Island Clonoe Colliery. The first pits sunk in that district were the Primate Pits, next the Alexander Pits, which never reached the coal, then the Bartley Pits; these pits were all sunk before my arrival, and all abandoned except the Bartley Pits. I have not, therefore, had the same opportunity of getting a minute account of the strata passed through as I have at the Lewin Pits; but the following is a correct *general* statement of the stratification of the Bartley Pits:—

	Yds.	ft.	in.
Clay	14	2	0
Red shiver	102	1	8
Fire-clay mixed with sandstone, slate, &c.	23	1	4
Five feet coal	1	1	0
Fire-clay	1	2	0
Grey post, mixed with white metal and ironstone girdles	10	2	0
	154	1	0

"Besides the five feet seam of coal, two other seams were discovered by a drift which was driven by my direction, which were not sunk through in the shaft; they are above the five feet coal; one, the shining seam, is eleven yards above it, and the other, the bone coal, is nine yards above the shining seam. These seams of coal are not regular like the one we have here, but have an undulating or wave-like surface.

"The stratum here called 'red shiver,' lies in thin beds of a dark red, and sometimes a purple colour; it sometimes contains sand, but not generally; the ironstone is in beds, two or three inches thick, which are generally four or five feet separate; the fire-clay is in beds, three or four yards thick, and is a very good kind of clay. The bone coal is of very inferior quality, it is about two feet at the thickest; the shining seam is an excellent coal, it is about two feet eight inches at the thichest, but mostly not more than a few inches thick; the seam called the 'five feet coal' is a good hard coal, about six feet at the thickest, but, like the shining seam, mostly not more than a few inches thick. There is a steam engine, twenty-four horse power, still standing on these pits, but the working of coal has been abandoned for the present."

The position of the Baltiboy coal, or lowest known seam of Coal Island, is shown by the accompanying sections.

Bartley West Pit.

	Yds.	ft.	in.
1. Mason work	4	2	6
2. Brown strong clay, surface	1	0	9
3. Blue ditto or marl	5	2	0
4. Brown ditto or marl	7	2	3
5. Red shiver, blue partings	2	1	6
6. Red shiver	99	0	0

		Yds.	ft.	in.	Yds.	ft.	in.
7.	Magpie (variegated sandstone)	1	2	0			
8.	Purple-coloured ironstone	0	2	0			
9.	Sandy bind, soft, purple and yellow	2	2	0			
10.	Strong purple bind	3	1	0			
11.	Purple slate, with a blue cast	5	2	0			
12.	Dark slaty bind, with plants	6	0	0			
13.	White metal, with clay beds and ironstone partings, and underlaid by black slate.	1	2	0			
14.	*Coal*	1	1	0			
					144	0	0
15.	Stourbridge or fire-clay	1	2	0			
16.	Coarse strong bind	1	0	0			
17.	Grey post	2	0	0			
18.	White metal	2	1	0			
19.	Dark slaty bind	2	2	0			
20.	White metal, with ironstone girdles	1	0	0			
21.	Leafy bind	1	0	0			
22.	Slaty ditto	3	2	0			
23.	Slate	2	0	0			
24.	Metal rock	0	1	0			
25.	Slaty clay	3	2	0			
26.	Black slate	0	2	0			
27.	*Coal*, Baltiboy	0	2	9			
	Total				166	2	9

In the East Pit the stratification is nearly the same in a general point of view, though the thickness of the several layers often varies, and indicates the true character of such deposits, which must have been subject to all the modifications of varying currents and eddies, thickening them at one point and diminishing them at another. This character of the ancient carboniferous bottom, whether it was the bottom of an estuary or of a lake, is remarkably similar to that of ordinary detritic deposits, and is another reason for believing that the latter were formed under the influence of marine or other currents.

Bartley East Pit.

		Yds.	ft.	in.
1 to 4.	Clays, &c., same as West Pit	60	0	0
5 to 6.	Red shiver	63	0	0
7.	Magpie	2	0	0
8.	Strong grey bind, with purple veins	2	0	0
9.	Strong grey bind	0	2	0
10.	Strong purple bind	3	1	0

	Yds.	ft.	in.	Yds.	ft.	in.
11. Purple slate, with a blue cast	7	0	0			
12. Dark slaty bind	6	0	0			
13. White metal	1	2	0			
14. *Coal*	1	1	0			
				147	0	0
15. Stourbridge or fire-clay	2	0	0			
16. Strong grey bind	1	0	0			
17. Grey post	2	0	0			
18. White metal	2	2	0			
19. Dark slaty bind	2	2	0			
20. White metal, ironstone girdles	1	0	0			
21. Leafy bind	0	2	0			
22. Slaty bind	3	0	0			
23. Slate	1	0	0			
24. White metal, with ironstone bands	6	0	0			
25. Black slate	2	2	0			
26. *Coal,* smut	0	1	0			
				172	0	0
27. Strong grey bind	1	0	0			
28. Strong grey bind	3	0	0			
29. Purple slate	4	0	0			
30. Grey sandstone	0	1	0			
31. Purple slate	1	2	6			
32. Black slate	0	0	6			
33. White sandstone	0	1	0			
34. Black slate and *Coal* smut	0	1	0			
				183	0	0
35. Strong Stourbridge of a purple colour	1	1	0			
36. Grey sandstone	0	2	0			
37. Purple-coloured slate	0	1	0			
38. Ironstone, purple-coloured	0	2	0			
39. Hard bastard whin	2	2	0			
40. Hard sandstone	1	1	0			
				190	0	0
To which was added by boring through hard beds of whin and sandstone				3	2	5
Total				193	0	0

On comparing these sections together, it appears that the superficial beds have increased in the East Pit from 19 yards, 1 foot, 6 inches, to 60 yards, and the red shiver diminished from 101 yards, 1 foot, 6 inches, to 63 yards. The magpie is a bed common to both, though varying in thickness, and from it to the seat of the five feet coal, there is a depth of 21 yards 1 foot in the West, 22 yards in the East Pit, of nearly similar composition and arrangement. Between the five feet coal and the Baltiboy seam, there are 22 yards of various ingredients, such as sandy and slaty binds, claystone, sandstone, &c. in the

West Pit, and in the East, after passing through a repetition of the same strata, with some small variations, the coal again appears 24 yards 2 feet under the five feet coal. The position, therefore, of this portion of the coal is the same in both pits; but in the East Pit it is reduced from a thickness of 2 feet 9 inches to 1 foot, and has become a coal smut without a floor of fire-clay, whilst below it and separated by 10 yards 2 feet of sandstones, shales, and binds, another bed of black slate and coal smut appears 1 foot in thickness, and underlaid by the ordinary floor of Stourbridge clay, four feet thick. Here, then, there is a case similar to that before noticed in Mr. Griffith's pits, but the seams, which there appeared to have united as they proceeded eastward, appear here to have separated in that direction, and whilst in that case the lower portion of the compound bed preserved its uniformity of distance from the seam of coal above it, it is the upper portion which has done so in this case, the beds separating from above downwards in the one, from below upwards in the other. These are curious facts, and the results here conjectured would be doubly interesting, were it possible to verify them by borings; they are, however, in perfect accordance with the arrangement of fine clay or sand amongst beds of gravel already alluded to.

In the Alexander Pit a considerable quantity of hard stone, the nature of which is not stated, was found interstratified with slaty and other binds, below a dark slate, with coal smut 1 foot 11 inches thick, and this representative of a coal seam was found at a depth of 94 yards, of various strata, including calcareous and cherty beds.

Such, then, appears to be all the recorded information of any value now existing on the borings or workings of the Coal Island Collieries; though it should be added, in reference to what has been before stated, that at Bradshaw's Pit the section passed through 17 yards of clay ground, and 25 of chalk and red sandstone, being the only known example in this field of the extension of the chalk over the coal measures.

Drumglass Collieries.

In this, the southern portion of the Tyrone Coal Field, a more complete record has been kept of the workings than in the northern, and by the kind and liberal communication of the Hibernian Mining Company of their maps, and the cordial assistance of Mr. Edward Sinclair, the viewer, at present, in charge of the working pits, a perfect plan has been constructed, which is given in Plate H.

Before entering on the details of working or mining of the only pits now in operation, the Lewin Pits, the records of the former borings made at the expense of the company, will be first given, as communicated, with the sanction of the Directors, by H. Porter, Esq., the secretary of the company.

Strata bored through on the Killybrockey side of Drumglass Coal Field, subsequently called the Queen's Pit.—(See Plate H.)

	Yds.	ft.	in.	Yds.	ft.	in.
Commenced in Mr. Cladrigan's field, Dungirvin.						
Clay and sand from the surface	6	1	3			
1. Red sandstone	1	0	3			
2. Grey slate	0	1	0			
3. Red bind	0	1	0			
4. Grey bind and slate	2	1	0			
5. Red sandstone	0	2	4			
6. Grey bind	0	0	4			
7. Black slate, intermixed with *Coal*	0	2	7			
				12	0	9
8. Grey slate and bind	0	1	7			
9. Grey bind	1	0	3			
10. Hard brown sandstone	0	1	8			
11. Yellow ditto	0	0	5			
12. Red ditto	0	0	3			
13. Brown sandstone, white partings	0	0	11			
14. Red sandy bind	0	1	2			
15. Grey bind, with mica	0	1	6			
16. Soft red sandstone	0	0	3			
17. Red bind	0	0	6			
18. Black slate, soft	0	0	8			
19. Brown bind, white partings	0	2	10			
20. Red bind	0	0	9			
21. Red sandstone	12	0	7			
22. Red bind, blue partings	0	2	2			
23. Hard red sandstone	0	2	5			
24. Soft red bind	0	0	11			
25. Hard red sandstone	3	0	4			
26. Red bind, white partings	1	1	7			
27. Hard red sandstone	0	2	2			
28. Soft red bind	0	1	0			
29. Red sandstone	0	0	5			
30. Red bind	0	0	6			
31. Red sandstone	0	0	3			
32. Red bind	0	0	6			
33. Hard red bind	0	0	10			
34. Hard red sandstone	0	0	9			

		Yds.	ft.	in.	Yds.	ft.	in.
35.	Red bind, white partings	0	0	5			
36.	Very hard brown rock	0	1	3			
37.	Hard red standstone	6	0	7			
38.	Grey sandstone	0	1	4½			
39.	Black slate	2	0	6			
40.	Hard grey bind	3	2	4			
41.	Soft black slate	1	1	0			
42.	Blue slate, white partings	0	2	0			
43.	Yellow bind	0	0	7½			
44.	Hard brown sandstone	1	2	9			
45.	Yellow sandstone	0	2	0			
46.	Brown sandstone	0	0	2			
47.	Yellow sandstone	0	1	5			
48.	Yellow slate bind	0	0	5			
49.	Yellow sandstone	0	0	4			
50.	Yellow slate bind	0	0	9			
51.	Yellow sandstone	1	0	11			
52.	Grey slaty bind	0	0	8			
53.	Yellow sandstone	0	1	7			
54.	Ironstone	0	0	5			
55.	Brown sandstone	0	1	1			
56.	White sandstone	0	1	8½			
57.	Grey slate	0	0	8½			
58.	*Coal*	0	0	2			
					60	2	1
59.	Blue slate bind	2	2	4			
60.	Hard yellow sandstone	2	2	6			
61.	Blue slate	3	2	0			
62.	Grey sandstone	1	2	2½			
63.	Hard grey bind	6	2	0			
64.	Ditto slate	2	2	2			
65.	Light grey slate	4	0	3			
66.	Foliated grey bind	0	2	11			
67.	Hard grey sandstone	0	2	5			
68.	Foliated grey bind	1	1	6			
69.	Hard grey sandstone	0	0	11			
70.	Hard grey bind	0	1	3			
71.	Very hard grey sandstone	3	0	4			
72.	Grey foliated bind	2	2	0			
73.	Hard black slate	2	1	3			
74.	Hard grey foliated sandstone	1	1	11			
75.	Very hard ditto	2	2	11			
76.	Hard yellow sandstone	3	0	6			
77.	Very hard grey foliated bind	6	2	8			
78.	Hard grey slate	2	2	6			
79.	Grey bind	0	2	0½			

	Yds.	ft.	in.	Yds.	ft.	in.
80. Very hard slate	2	2	9			
81. Very hard black slate	0	2	2			
82. *Coal*	1	1	10½			
				120	0	0

To the seat of the coal in the borehole 120 yards, 2 feet, 5½ inches; dip 1 in 4½; bearing by compass north 53° east.

No. 1.—*Borehole put down at the direction of Mr. Thomas Forster, of Haswell Colliery, Durham,* 1833.

	Fa.	ft.	in.
From surface to stone	2	4	0
Soft blue metal, mixed with balls of limestone, much water	7	3	0
Same ground	1	5	0
Grey limestone, mixed with blue metal and spar	2	4	0
Same ground	5	2	0
Same ground	3	4	10
Same ground	3	5	0
Same ground, 1 fa. 0 ft. 7 in., limestone, 1 ft. 3 in.	1	1	10
Same ground, very clammy	3	4	5
Same ground	5	1	0
Same ground, but darker and harder	3	4	11
Same ground, hard and soft alternating	3	0	6
Same ground	3	0	8
Same ground, 2 ft. 10 in. hard limestone	2	3	0
Same ground	2	3	4
Same material, but softer, 1 ft. 5 in. hard limestone	1	2	4
Nine ft. 3 in. same ground, remainder dark grey metal	3	2	1
One ft. 11 in. hard bastard limestone, 10 ft. dark grey metal	1	5	11
Dark grey metal	2	3	11
Same ground	2	5	2
Same ground	2	2	8
Same ground	2	0	7
Same ground	2	0	8
Same ground, but rather stiffer	1	3	9
Same ground	1	5	2
Same ground	2	0	2
Same ground	1	1	4
Same ground, with hard limestone girdles	0	2	11
Same ground	1	5	0
Same ground, hard girdle 9 in.	1	4	6
Same ground, hard girdle 14 in.	4	1	2
Same ground	1	1	6
Same ground	1	1	11
Same ground	1	0	9
Same ground and hard lime	0	1	8

	Fa.	ft.	in.
Hard limestone	0	0	2
Hard limestone	0	0	3
	90	5	1

Stopped from the unpromising character of the strata.

No. 2—Borehole put down at the direction of Mr. Thomas Forster. of Haswell Colliery, Durham, 1834.

	Fa.	ft.	in.
From surface to stone	2	4	0
Dark grey metal stone, with limestone girdles and white spar	10	3	10
Same description of ground	6	1	6
Same ground	4	2	0
Same ground and a stratum of hard limestone	4	2	3
Hard stone, doubtful whether lime or whinstone	0	1	11
Hard limestone	0	0	10
Hard limestone, with beds of whinstone mixed	0	0	11
Ditto ditto	0	0	9
Ditto ditto	0	0	10
Ditto ditto	0	0	5
Ditto ditto	0	0	8
Same stone, but rather softer	0	1	0
Ditto ditto	0	1	3
Ditto ditto	0	1	0
Dark blue metal, with grey girdles	2	0	4
Ditto	5	1	0
Ditto	4	4	9
Ditto and 1 in. in hard limestone	3	5	7
Grey metal stone, with lime	0	5	11
Ditto	1	3	5
Hard limestone	0	1	6
Ditto	0	1	9
Ditto	0	3	1
Grey metal	1	0	6
Hard limestone	0	1	5
Ditto	0	2	2
Ditto and grey metal	0	4	5
Hard limestone	0	2	2
Same ground	0	1	10
Same ground	0	1	9
Same ground	0	1	6
Ditto and metal partings 14 in.	0	2	8
Metal, stiffer than before, with lime and white spar	1	4	4
Metal stone	3	3	4
Metal stone	0	4	8
	59	3	3

The rods broken, and further progress stopped.

No. 3—Borehole put down at the direction of Mr. Thomas Forster, of Haswell Colliery, Durham, 1835.

	Fa.	ft.	in.
From surface to rock	2	1	0
Blue metal stone	3	2	0
Blue metal	6	1	0
Same stone	4	4	0
Same stone	10	0	0
Same stone 8 ft. (limestone 3 ft.) under limestone 2 ft.	2	1	0
Blue metal, with a hard stone 8 in. thick	6	4	0
Blue metal, mixed with a white spar	5	0	0
Blue metal, with limestone 6 in.	4	5	0
Blue metal 17½ ft., limestone 1½ ft.	3	1	0
Hard limestone	0	4	6
Limestone 4 ft. 6 in., 3 ft. blue metal	1	1	6
Blue metal 2 ft., limestone 5 ft.	1	1	0
Hard limestone	1	1	0
Ditto	0	3	0
Limestone 1 ft. 6 in., blue metal 3 ft. 6 in.	0	5	0
Blue metal, with less limestone	5	1	0
Blue metal, with a greater proportion of lime	6	1	0
Blue metal 6 ft., hard limestone 4 ft.	1	4	0
Hard limestone	0	1	0
Hard limestone and blue metal	3	3	6
Dark blue metal 9 ft. 4 in., limestone 8 in.	1	4	0
Blue metal 15 ft., limestone 1 ft. 6 in.	2	4	6
Limestone 6 ft., blue metal 2 ft.	1	2	0
Blue metal 3 ft., limestone 5 ft.	1	2	0
Blue metal and limestone	2	2	0
Blue metal 14 ft., limestone 1 ft.	2	3	0
Hard limestone	4	1	0
Same stone, rather softer	0	3	0
Bastard whin	0	2	0
Same stone	1	1	0
Blue metal, mixed with lime	0	2	0
Same ground	0	2	2
Same ground	4	0	2
Very hard limestone, mixed with spar and sulphur	0	0	6
Hard lime and freestone	0	1	6
Same ground	0	1	6
Blue metal, with lime	0	1	6
Blue metal, 2 ft., hard limestone 6 in.	0	2	6
Blue metal, mixed with lime	0	3	6
Blue metal, with lime and white spar	0	3	0
Hard stone	0	2	0
Hard limestone	0	1	0
Hard limestone 10 in., soft blue metal 4 ft.	0	4	10

	Fa.	ft.	in.
Hard blue metal, with lime and white spar	0	1	0
Blue metal 4 ft., limestone 2 ft.	1	0	0
Limestone, blue metal, and spar	0	4	0
Hard limestone	0	2	6
Hard limestone 1 ft., blue metal 1 ft.	0	2	0
Ditto 1 ft., blue metal, with lime and white spar, 1 ft.	0	2	0
Limestone, increase of water	0	2	6
Limestone	0	1	0
Blue metal 4 ft., limestone 6 in.	0	4	6
Blue metal, mixed with lime	0	2	0
Soft blue metal, mixed with lime and white spar	1	0	0
	102	3	8

These borings were evidently injudicious, and in strata below the coal measures; they are valuable as showing the nature of the underlying limestone deposit.

Proceeding to the description of the Lewin Colliery, which is now the only one at work in this portion of the field, I shall use, as nearly as possible, the words of Mr. Sinclair, and, as in the preceding case, append to his description my own remarks.

Section of the strata passed through.

	Yds.	ft.	in.	Yds.	ft.	in.
In sinking the shaft—						
Clay	1	1	6			
Steel marl (strong blue clay)	6	2	9			
Blue and grey shale	29	0	6			
Black stone	0	1	6			
Coal	2	0	6			
				40	0	9
Sandstone	8	1	0			
Blue shale	0	0	3			
Sandstone	1	1	0			
				50	0	0
Continued by boring—						
Blue shale	0	2	0			
Sandstone	0	0	10			
Black stone	0	1	2			
Sandstone	0	1	0			
Blue shale	0	2	4			
Sandstone	0	2	0			
Blue shale	0	0	9			
Sandstone	0	0	8			
Blue shale	1	0	0			
Black slate	0	0	5			
Sandstone	0	1	2			
Total by sinking and boring,				55	0	4

"I will here describe what is technically called 'the winning' of this colliery. One of the shallow pits near the outcrop of the coal, which is marked on the plan, was first sunk; afterwards one of the pits where the steam engine now is. The first pit reached the coal at a depth of twelve yards; the water and material excavated were raised by manual labour; the coal here was thin, but appeared to increase to the dip, and the second pit was sunk to prove it; this pit reached the coal at a depth of thirty-eight yards. On the coal being cut a feeder of water burst away, which rendered it necessary to use some more powerful machinery; accordingly a single-horse whim-gin was erected, this being sufficient to raise about 200 tons of coals weekly, besides draining the water; levels were then driven in the coal in each direction from the pit, and the appearances being good, the erection of a steam engine was immediately begun, and another pit was sunk near the gin pit to facilitate the raising of coals; this pit reached the coal at forty yards.

"It was my intention to introduce similar machinery for raising coals to that now in general use in the north of England, and that this might be done effectually, I determined to sink the two last mentioned pits, which are now called the Lewin Pits, a few yards farther, and cut the coal by a drift to the dip; as soon as the engine was completed this was begun, and the pits sunk twelve yards under the coal, which was cut by a drift to the dip. There was no difficulty experienced in sinking until the coal was passed through, as the strata lying above the coal are easily worked without using gunpowder; but after that the sinking became very difficult, as the strata were so hard that great quantities of gunpowder had to be used in blasting, the application of which was rendered extremely difficult by the great quantity of water, which had increased to about eighty gallons a minute, and which is now about 120 gallons a minute.

"In consequence of the appearance of the strata at the bottom of the pits, which was indicative of coal, I was induced to commence a bore-hole in search of another seam under the one we are at present working; when this was five yards deep a very great feeder of water was cut, which was with great difficulty stopped; the appearances indicative of coal increased as the borehole went down, and I entertain little doubt that there is another seam of coal under our present one, but this I was prevented from proving by the water above mentioned.

"The coal is thrown into a vertical position a little to the west of the pits, the course of this upthrow is about north-west. As far as has been proved the coal is about six feet in width in the upthrow, and what we have worked of it has been taken away in galleries about five yards above each other. In our other workings, the coal is lying in nearly a horizontal position.—(See, for the upthrow, Pl. G., fig. 5*.)

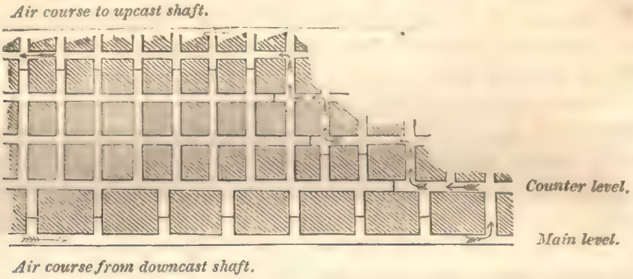
"There are two principal shafts, the one for raising the coal, the other for discharging the water: the first is 4 ft. 6 in. square and 52 yards deep, being lined with plank $1\frac{1}{2}$ in. thick, which is secured by frames of timber scantling 6 in. by 4 in. in thickness, placed at every 18 inches. The other is circular, 4 feet diameter, and lined with fire-brick, descending about 9 feet below the first shaft.

"The main level is driven from nearly the same level as the bottom of the water shaft, with a rise just sufficient for the water to flow easily to that shaft; about twelve yards to the rise of this level is another called the counter level, these levels are driven to explore the coal, and communications are made between them at convenient distances for ventilation, and for roads through which to bring the coals from the rise. From the counter level upsets are turned every twelve yards where the coal is regular; two of these are worked constantly till they are near the outcrop of the coal, one of them is then fitted out for an inclined plane or lever hill; from the top of this, two levels are driven, one on each side, which are called the lever hill levels, and the upsets from them are continued to the outcrop. Between the upsets communications are made at every twelve yards, and thus squares or pillars of coal are formed.

"When the lever hill levels have been extended as far as is deemed prudent, and the upsets have all reached the outcrop, the pillars are then removed, beginning with those farthest from the lever hill, and when they have all been removed but those next to the lever hill, the inclined wheel is removed further down the hill, and the same operations are repeated.

"As the main and counter levels are constantly advancing, new upsets are constantly being begun, and new lever hills are required; where the roof will admit of it a lever hill is formed every 150 yards, but much depends on the hardness of the stratum which forms the roof, as the upsets for lever hills require to be driven very wide, and where the roof is soft it is difficult to support it.

"As we have no inflammable gas to contend with, the ventilation is comparatively easy, as it is sufficient to keep a good current of air in the working heads, and as shafts can be sunk near the outcrop, at a small expense, it is not necessary to keep up long air courses; we have recently sunk a shaft near the outcrop, and not far from the extremity of our workings, which has shortened our air course very much; at present the distance travelled by the air underground is about 1200 yards, it descends the coal and water shafts, and is drawn to the shaft where it ascends by a furnace four feet in width; it goes into the workings by the main level, and returns by one of the upper levels to the upcast shaft, passing through all the working coal heads, as the following diagram will explain:—



“It will be seen by this diagram that the communications between the main and counter levels and between the upsets are stopped up as soon as new ones are made, so that the air is always forced through the heads where the men are working.

“The men and boys employed underground, with their ages and average earnings, are as follows:—

9	above 10	and under 12	years earn per week	4*s.*
28	12	20		9*s.*
56	20	40		14*s.*
11	40	56		14*s.*
Total 104				

“The youngest boy is ten years old, the oldest man forty-six. Ten hours is considered a shift or day's work here, but as the greatest portion of the work is piece-work, and as we have more men than are fully employed, the majority of them do not work more than nine hours. There are 14 surface labourers, 2 engine men, 2 stokers, 1 carpenter, 2 sawyers, 2 smiths, and they are paid as follows:—the surface labourers (screeners, &c.) 1*s.* 2*d.* a-day, smith 2*s.* 6*d.*, carpenter 2*s.* 6*d.*, pair of sawyers 4*s.* 6*d.*, enginemen 2*s.*, and stokers 1*s.* 2*d.* The day's work is twelve hours in summer, out of which an hour and a half must be deducted for breakfast and dinner, and eleven hours in winter, with three quarters of an hour allowed for breakfast and dinner. And besides these payments, about £3 weekly are expended in paying for carrying coals to lighters at Coal Island and Moy, and about twenty carmen are also employed in leading coals to various places and bringing pit timber. Two mules are employed in the levels drawing the coal trucks.

“The mechanical power applied is a high pressure engine of about 20-horse power, 15-inch cylinder, and 2 ft. 6 in. stroke, capable of raising 360 tons of coals per day of 24 hours, and discharging 130 gallons of water per minute, or allowing 50 minutes per hour, 156,000 gallons per day of 24 hours. And in addition to this machinery actually in use, the company have in their possession.

"One 90-horse condensing engine at Drumglass Old Colliery, not working.

"One 24-horse power high pressure engine at Clonoe Colliery, not working.

"One 35-horse power condensing engine, in store.

"One horse engine, 5-horse power, ditto.

"Two double-horse whim-gins, ditto.

"There are two screens, the bars of which are half an inch apart. The best coals, besides being screened, are sifted in a riddle, the meshes of which are three quarters of an inch square. The proportion of slack coal is about 60 per cent. The slack consumed by the engine and on the establishment amounts to about 45 tons a month. There is no unsaleable slack, nor is any left in the mine."

The sales of coal, as stated by the Secretary, at all the collieries of the company have been—

		Tons.	Average Price.
At Drumglass and Lurgaboy Collieries,	1829	7,690	7 11
	1830	30,265	7 11¼
	1831	22,758	7 10¾
	1832	23,425	7 9¼
	1833	23,635	7 1½
	1834	19,542	7 6¾
	1835	17,535	7 9
	1836	14,550	8 8½
	1837	14,102	8 11¼
Half year	1838	4,700	8 6
Total,		178,202	7 10¾
At the School Land Colliery, from Dec. 1838 to Dec. 1841		20,825	8 7½
At the Drumglass New Colliery, the half year, ending Dec., 1840		1,093	7 1¼
The year 1841		11,141	7 5¾
The half year, ending June, 1842		8,059	7 7½
		20,293	7 6

This colliery I visited on the 28th of October, and was accompanied through it by Mr. Edward Sinclair, the viewer in charge, who afforded me every facility in my inspection of the workings, and seemed desirous to make me fully acquainted with all the details of the establishment. It is conducted upon the best principles, and there is an air of neatness and finish in all the operations, mechanical ingenuity wherever it is practicable to apply it, being called into action, to diminish manual labour. The planking of the square shaft used for raising the coals is set close, so that the sides are comparatively free from the discharge of water; vertical slides are attached to the sides of the shafts, by which the water barrel and the coal boxes are guided quietly and smoothly up and down without the possibility of being deflected from side to side in their passage. The water is raised in a barrel containing 130 gallons, which is suspended on swivels, and is easily emptied by one man, who reverses it over a trough, by which the water is carried off; the coal is raised in boxes or trucks, each containing six cwt. The loaded truck is supported on a frame, constructed as a portion of a double rail, and suspended by chains; when it arrives at the mouth of the pit, the frame is secured by a catch, and becomes a portion of a small railway leading to the screens; the loaded box is pushed off it towards the screen, and its place is supplied by an empty one from the opposite side, when the catch is freed, and the frame and its box again descend into the pit. The notice to draw up the box is given by a lever or hammer, which is placed near the pit mouth, and strikes upon an iron plate on being moved or raised by a string which connects it with the bottom of the pit, a mode of conveying the signal to haul up, as simple but far more neat than shaking the rope. Mr. Petherick has now erected a circular saw, 3 ft. 6 in. in diameter, which is connected with and moved by the steam-engine.

Descending the shaft; the main level was driven 35 yards in sandstone, and in its further course runs for 50 yards along the roof of the coal; it was designed six feet high and six feet wide, but owing to the imperfection of the roof and floor, it has been reduced to five feet high and six wide. The great pressure upon the roofing timber has bent many of the cross beams, but with the exception of a few unfavorable spots, the height of the levels is such that they can be walked through without inconvenience, and they are sufficiently commodious to admit of the employment of mules in drawing the trucks. These animals are regularly stabled in the mine, and are found to improve in appearance and condition by their underground habitation. The floor, as in the Coal

Island Mine, is subject to swell, an evil which is increased by the quantity of water running through the levels, and in one spot it had extended so far as to render it necessary to secure the floor by a reversed brick arch, which has proved an effectual remedy. The upsets are five feet high and six or even eight feet wide, when the roof is good; those, which are intended for inclined planes, or, as they are locally called, lever levels, are made nine feet wide, the centre being supported by upright timbers, which divide the upset into two parallel galleries, down one of which the loaded truck descends, whilst the other ascends in the adjoining one: at the top of the lever level is fixed a horizontal, or rather an inclined wheel, four feet in diameter, round which the rope passes, which moves and connects the trucks. At present there are two lever levels, two levels, eight upsets, and one downset; but in case of increased demand, it would be possible to work from the first inclined plane, three levels and three or four upsets, and from the second, four levels and six or eight upsets; and, in like manner, it would be possible to add at least one-third to the current performance of the present steam-engine. The seam of coal usually varies in thickness from four to six feet, but in the main level it is now nine feet, and in one place was 14 feet thick; it is separated into two layers by a parting of fire-clay, which is also of varying thickness, sometimes becoming evanescent, and in one place swelling to a thickness of 13 feet, mixed with thin beds of bluish sandstone. The rolls or waves in the seam are curious, and may be seen to advantage in the second advanced level, where one of them bends over an angular projection of the sandstone, the inclined face of which is coated by a fine layer of fire-clay. The remarkable upthrow represented in the section, Plate G., fig. 3*, is most probably a similar roll on a grand scale, as there is no appearance of dislocation or of deterioration of the coal, and its general character is more in accordance with the phenomena of rolls than of faults, the seam and its parting of clay remaining the same throughout. In the course of the workings the coal was lost for fifty-seven yards, but refound in the same line of direction, detached or lenticular portions, never more than six inches thick, met with in the intervening space, having encouraged the miners to proceed, the *trouble* being unaccompanied by a fault. The coal is good, but is more laminar in arrangement than in the five feet seam of Coal Island; it comes out, not in large cubical blocks, but in slabs, which, when broken up, supply pieces of very fitting size for domestic purposes: this character strongly distinguishes it from that of Coal Island, a large portion of which is very compact. Mr. Sinclair remarks on this point, "Our coal differs in quality from either of the seams of Coal Island; it contains more bitumen, cokes well, and is much better adapted for household purposes than the five feet coal, but is not so good as the shining seam, as it is mixed with thin bituminous slate partings which burn to white ashes."

In closing the notice of this colliery, it is impossible to avoid expressing the gratification produced by the regularity and neatness of its operations, and by the obliging readiness of the viewer, Mr. Sinclair, to point out and explain everything connected with it. But whilst the manner of working the colliery deserves approbation, the same regret must be expressed that no means are adopted to extend the demand and augment the supply. The machinery at the command of the Company is sufficient to keep in check a much greater flow of water than the present, (although it has recently been found necessary to put down a set of six inch lifting pumps), and to raise a correspondingly increased quantity of coal, and it is only necessary, therefore, to create a demand which should render such additional efforts necessary. The present price of large screened coal at the pit's mouth, at the Annagher Colliery, is 13*s.* 4*d.* per ton, and of small coal from 5*s.* to 8*s.* 4*d.* per ton; at the Lewin Pits, the average price of all the coal is 7*s.* 10*d.*, prices which, though they might appear low in the market, are, at the pit mouth, high; and, as the limitation of the range of supply will in fact depend on the original cost, any reduction in the price has a tendency to spread farther the use of the coal. If a day's labour of horse, cart, and man be estimated at 5*s.*, the load carried on a good road being fifteen cwt., and the day's journey twenty miles or ten miles to and fro, one mile of distance from the pit adds to the cost 8*d.*, two miles 1*s.* 4*d.*, three miles 2*s.*, four miles 2*s.* 8*d.*, five miles 3*s.* 4*d.*, six miles 4*s.*, seven miles 4*s.* 8*d.*, eight miles 5*s.* 4*d.*, nine miles 6*s.*, ten miles 6*s.* 8*d.*, and so on, every mile of distance adding 8*d.* to the cost; hence the best coal from Annagher would cost, at ten miles from the pit, 21*s.* 4*d.* per ton; whereas

Wigan coal is delivered in Dublin at 17*s*. per ton. The reduction of 8*d*. per ton would add one mile to the range of supply; and if this principle were attended to, contracts for the transport of the coal entered into by the proprietors, and depôts formed for its sale, the demand would speedily rise, and renewed exertion be required both to explore the field for new, and to work out its already known beds.

The fossil plants of the Drumglass coal appear to have been abundant and in immediate connection with the seam; those in the Survey collection from the old pits are Sigillaria *organum*, Lepidodendron *Sternbergii*, L. *elegans*, L. *obovatum*, (in the grits); in the Lewin Pits they are very rare; principally impressions of Calamites on the sandstones.

The question naturally arises as to the relation of the seams of Drumglass to those of Coal Island, whether they are the same, brought down by a great fault, or other seams entirely below them? On examining the sections, a very great difference will be observed in their indications. In the Drumglass section the first coaly matter, mixed with black shale, appears 12 yards 9 inches from the surface, of which 4 yards, 2 feet, 11 inches are red sandstone. The second a seam of two inches, at 57 yards, 1 foot, 11 inches; 27 yards 1 foot of the intervening strata being hard sandstones of variable colour: and the third coal 4 feet 10½ inches thick, at 119 yards 7 inches from the surface, 16 yards, 1 foot, 8 inches of the intervening strata between this and the preceding being hard sandstones, and the rest principally hard binds and shales. The roof of the coal is a hard black shale. The general character of the section has, therefore, changed; the strata are much more indurated, and claystones have disappeared, whilst the only accordance in the position of the seams is, that the distance between the two-inch seam and the six-feet approximates to that between the upper or crow coal and the five feet coal. The nature of the red sandstone associated with the coal measures in this section may be judged from that of Edendork, which crops out to the west of Coal Island district. It is a coarse red grit, rich in distinctive coal fossils, amongst which are Lepidodendron *Sternbergii*, L. *aculeatum*, Calamites *nodosus*, Sternbergia *approximata*, and some other species not at present identifiable. The great development of such hard beds and shales indicates that a different portion of the section has been arrived at, and that the seams of Drumglass are separated from those of Coal Island by a considerable thickness of red grits; and even if the five feet seam could be considered cotemporaneous in the two localities, the great difference in the character of the coal measures would prove that their present relative positions are not the result of faults. The great difference in the character of the coal which is more laminated and mixed with shaly matter, is another proof of the distinctness of the seam from those of the northern portion of the district. It is to be hoped that ere long the space between the Lewin Pits and the old Drumglass Colliery will be proved, as at present the relation of their respective seams to each other is unknown; and until this is determined and the extent of the field properly investigated, any estimate of the supply to be anticipated can only be conjectural. The Drumglass seam is not exhausted, and there can be no doubt that the working upon it will be hereafter resumed, and be rendered effectual by the sinking of new pits and by proper attention to the machinery. Plate H. shows that the workings were carried to a great extent from the same pit, and though the roof was better than in the Annagher Colliery, the difficulties must have been much augmented by the distance. The mountain limestone limits the field on the south, but as the strata of that formation have also been subjected to much dislocation and disturbance, the coal measures might have been deposited beyond the broken line of its outcrop: the trials made in the borings Nos. 1, 2, 3, page 616, were, however, injudicious and hopeless, as the boring was entirely in the limestone. Such a trial should have been guided by the analogy of the sandstone; and if made at all, the boring should have been arranged in a position, similar to that of the Lewin Pits in respect to the sandstone adjacent to them. An inspection of the map will explain what is here meant, but there can be little doubt that it would have been better to devote such efforts and expense to the exploration of the Drumglass field itself.

If the line of strike of the Drumglass limestones be noticed on the map, it will be evident that they cannot be said to limit, excepting in a very partial manner, the coal deposit of Coal Island as they are transverse or oblique to its probable margin.

The boundary appears to be completed by the red grits of Edendork, and if such be the case, and the Drumglass and Lewin seams are under that grit, there does not seem to be any good reason why other seams should not yet be found under them. The field, in short, has been only superficially explored.

Annaghone and Templereagh Pits.

The deposit of coal measures and coal in which these pits were sunk rests directly upon the *lower limestone.* It corresponds to the Coal Island deposit, of which it appears to be a continuation, and is another reason for believing that in the intervening space between the two the coal measures may yet be found within the outcrop of the new red sandstone. The Annaghone Pits have not been worked for about twenty years; the order of succession, according to the report of the miners, is,

	Yd.	Ft.	In.	
Soft shale and clay	55	0	0	
Crow Coal, from 6 ft. 3 in. to	0	1	6	
Sandy shale, called "parrot"	10	0	0	
Main Coal, from 1 yd. 0 ft. 6 in. to	1	1	0	occasionally 6 or 10 ft.
Sandy shale	10	0	0	
Coal (shining seam)	0	1	6	

The surface of the crow coal was very irregular, abounding in swells or "horse backs;" the main coal was a fine, rich, flaming coal, breaking into large lumps; the coal of the shining seam was excellent, but it was very little worked. In Templereagh two pits were sunk about five years ago; the upper coal was met at a depth of fifty-two yards, and was the only seam worked; the coal was abundant and tolerably good, though not breaking large, and the workings were successful, but soon discontinued by the proprietor, as the Coal Island Colliery was considered sufficient to supply the demand. The colliers state that the seams rise and entirely thin out towards the north and southwest; and that the upper portion of coal is quite dry and free from water springs. The manner in which the seams rise, as compared with those of Coal Island, corresponds to their position at the opposite extremity of the basin. If the relative position of the seams be examined, the distance between the crow and main coals agrees tolerably with that between the crow and Annagher coals; but the space between the main coal and the shining seam is only half of that between the *Annagher* and *shining seam* in shaft No. 2 of the Annagher Colliery, and the third or *bone coal,* is deficient. Here, then, is an illustration of the case in shaft No. 1 of that colliery, where it was suggested that the bone coal and Annagher coal had become united in one seam (p. 609), though the distances between the seams have here greatly diminished.

CHAPTER XIII.

DETRITUS.

Few subjects, in the whole range of geological inquiry, have of late engaged so much attention as the origin and mode of distribution of gravel, and although the result investigated is one of the most recent effects of natural causes, one indeed which appears only to anticipate by a very brief period the operations of the submarine current or of the tidal wave, it is still involved in obscurity and the subject of controversy. How little reason, then, is there for surprise that the sands and gravels of more ancient epochs should prove problems of difficulty and doubt.

As agencies by which the superficial covering of detritus may have been formed and spread, the rush of diluvial waters, marine currents, local deluges from the bursting of lakes, floating ice, and glaciers, have by turns been cited; and in this, as in almost every other inquiry, local peculiarities have been magnified into general results. In investigating this subject, it is desirable to bear in mind that fine gravel and boulders are not necessarily connected together, except so far as they may have been under the action of the same remote causes. In the present ocean the marine current is forming its bank, and the iceberg conveying its boulders; the direction, therefore, of the bank and the position of the boulder are influenced by the course of the current; but it is not necessary that the ice which conveys the boulder should have any direct action in forming the bank; and the same reasoning is equally applicable to more ancient deposits, if considered the result of similar causes. In general it will be observed, that where large boulders and fine gravel or gravelly clay are mixed up together, the mixture is a confused mass; and, on the contrary, where sand, gravel, and clay are arranged in alternating or distinct beds, the boulders rest independently on the top of the whole. As examples of the first of these cases, may be cited the great masses of gravelly clay, mixed with large lumps or boulders of mountain-limestone in the neighbourhood of Enniskillen, and the lumps of limestone similarly mixed with the detritus of Armagh; and again, the confused heaps of large granitic and hornblendic boulders to the north-west of Slieve Kirk, in Derry; but it will at once be evident that the last example, though in part corresponding to the first, is not exactly of the same character. In Enniskillen and Armagh, the local boulders predominate both in size and quantity; and there is no necessity for supposing that the moving forces which heaped them up and mixed them with the gravel in one bank or mass, had any very extended sphere of action; such heaps, therefore, may be ascribed partly to long continued wear of the shore rocks and reefs, and partly to the action of beach ice, moving alternately to and from the shore: at the north-west of Slieve Kirk, the granitic and hornblendic boulders are, on the contrary, of very great size, and form a large proportion of the whole: they are apparently accumulated together in consequence of the obstruction to their progress, arising from the elevated ridges of mica schist; and this view of the case is confirmed by the fact, that to the north of Warbleshinny and along the course of the opening between it and the Innishowen Mountains, or in the direction of Lough Foyle, granitic and other primary boulders are frequent, although in the more southern portions of Derry, they become very rare, or are reduced to fragments of small size in the gravel. Here, then, the moving masses must have had an extensive sphere of action, bringing the boulders from the north-west, and depositing them at the base, or at least against the side, of the mica schist hills; and it is most probable that the moving agent was floating ice, and that the epoch of movement was subsequent to the elevation above the sea of a portion of the mica schist, and, consequently, subsequent also to the deposition of the more elevated sands and gravel. The frequent occurrence of lumps of a petrosiliceous porphyry, which appear to have had their origin in the hill of Crohan, near Strabane, is another proof that a current has here set in from the west to the east.

Many other examples of local boulders might be adduced, such as the basaltic lumps, exposed by the streams along the face of the basaltic cliff; the huge fragments of gneiss, mica schist, and the associated hornblendic rocks, similarly exposed by river courses, along the line of the mica schist, and the fragments of local sandstones in the detritus, near Pomeroy, in Tyrone. On the Castle River, parish Drumachose, the boulders are, in the higher parts, principally basalt, mixed with fragments of schists, but in the more expanded plain below, the large trap boulders are associated with lesser of granite and sandstone. On the Roe below the gap, large lumps of the schistose rocks, some five feet long, are heaped up and packed together, three or four feet above the present river level; and very similar cases of lumps and of large gravel occur on the course of many other rivers, as, for example, in the Glenrandal (Upper Cumber), where a large gravel of fragments, one to two feet in diameter, forms the base of the open flat of the river, and still higher up are met huge boulders, near the remarkable detritic knoll which separates the fork of the river at the junction of Straw and Altaghoney. At Sluggeda there are boulders, varying from seven to eight feet in diameter, of hard schist; and on the forks of the Faughan, at the base of Sawel and Dairt, the bank is scarped for about twenty feet, and displays similar lumps from seven to nine feet in diameter. In the parish of Lissan, similar accumulations of local boulders of the schists and metamorphic rocks occur; but it would be useless to go further, as the fact may be observed along the course of almost every mountain stream; and although the actual position of such boulders is sometimes in part due to the action of the swollen winter torrents of the existing streams, it is probable that they have been accumulated by more remote causes, and only freed, by the more recent, from the clayey or sandy mass in which they had been enveloped. Such accumulations may have taken place at several and very distant epochs; some on high ground may have emerged, by elevation, from the ocean, prior to the accumulation of other heaps in lower positions, but there is here no satisfactory clue to the solution of the problem.

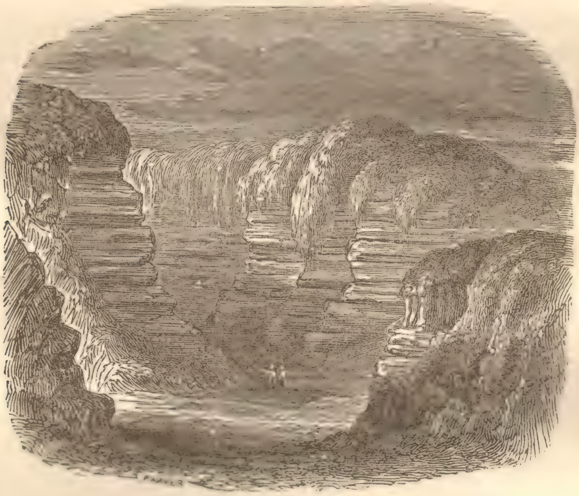
Proceeding now to the consideration of the finer detritic matter, or sand and gravel, some caution is necessary, as the appearances may be much affected by the manner in which the deposit is exposed; if, for example, the thick cap of gravel, which so often surmounts fine detritus, were alone cut through, the resulting effect would be, as it were, a confused mass, similar to the accumulations of boulders, and not part of a more regularly arranged deposit. Such accumulations of gravel, of considerable thickness, do sometimes occur, and may be studied on the Faughan, near Mr. Acheson Smith's, but the more usual system is one of alternating fine and coarse materials. Very beautiful examples of alternating beds of fine sand, clayey gravel, and lines or beds of pebbles may be observed in the small rivers or streams which pass through the detritus on the north of Derry, and discharge into Lough Foyle; for instance, the Ballykelly River: in all these streams, as also in the Faughan, the Moyola, &c., the existing water channel is sometimes narrowed between rocky or at least solid banks, and sometimes occupies a narrow riband-like space within an expanded flat, which is itself bounded by elevated and retired banks. In such cases the flat is sometimes overflowed by the river, as in the Stranagalwilly: but in many others, the low internal banks of the stream are high enough to restrain its waters within their limits, and the retired banks were therefore the result of a more remote scarping action of the water. This system of lake-like expansions, with flat bottoms of sand, or sand resting on pebbles, and bounded by retired banks, is common, and there are sometimes, though rarely, appearances of a step or secondary bank between the higher one and the true river boundary. An example of this kind occurs on the Roe, at the high level flat above the Dog Leap, and in a less marked degree on the Burnthollet, below the Ness waterfall, where it appears connected with the ancient river beds, figured in woodcuts Nos. 22, 23, pp. 176-177; but in neither case does it seem necessary to refer to elevations or to glaciers, as the result is probably due to the lowering of the ancient lake or river, either by the abrasion or bursting of its boundary, though such an effect may have been facilitated by cracks or dislocations consequent on internal movements. The more general effect is probably due to the simple wear of the river or stream into the great mass of superficial detritus; the lake is discharged, and the river then gradually sinks its humbler channel into the flat lacustrine bed.

The manner in which arrangement is manifested in detritic beds is various, and some of the more remarkable forms are delineated in Plate I. One of the most simple is a domed bank of sand, the layers of which are separated by thin clay partings, covered by gravel; this is represented fig. 1. In some cases the nucleus is principally clay, and it seems impossible to ascribe the deposition of such thin alternating layers of sand and clay to any violent action; it appears indeed to indicate something like alternating tidal ebbs and flows in an estuary, and the gravel becomes the representative of the drift by which the bank was subsequently covered. The next form is an alternation of sand and gravel: in fig. 4 there are several such alternating beds, the lowest visible layer being sand, and the upper a clayey gravel; they are observed to possess a general character of regularity, and it is clearly impossible to reconcile such a form of arrangement to any one violent rush of water, or even to the unintermitting action of the same current moving with the same degree of velocity. It would rather appear that the sand should be here considered the principal deposit, extending probably over large spaces, and varied in different localities by beds or ridges, as the case may be, of gravel poured in upon it by either periodical or casual currents of varying intensity. If this be the case, great differences may reasonably be expected both in the nature of the sand and in the mode of its alternation with coarser materials. In fig. 6 the gravel and sand are more mixed together, and the gravel more abundant, though there is here a parting of clayey sand, which indicates a period of comparative rest, and a very coarse or large gravel at top, which indicates an augmented force of movement. The manner in which the deposit has been occasionally influenced by local causes is seen in fig. 5, where the bed of fine sand is divided into two, just in the same way as the seams of coal in Chapter XII., pp. 609-613; and in figs. 2 and 3 are examples of those more confused mixtures of fine sand and gravel, or fine laminated sand, coarse gravel, and clay, which appear to be the result of eddies, and are very common in gravel deposits. The lamination of the sand, noticed in fig. 3, is seen to great advantage in the curious deposit of gravel, gravelly clay, and fine sand, in the White Water River, fig. 8; the lower portion is here clayey gravel, with an occasional distinct line of pebbles, and this is surmounted by sand and gravel in numerous alternations, one layer of considerable thickness being laminated in a transverse direction, very similar to the lamination of sandstones, as represented in Plate C., figs. 11, 12, 19; there is indeed a very striking resemblance in the arrangement of the beds or layers cf detritus in several of these sectional views, to that of the sandstones in the corresponding views of Plate C., as may be at once seen on comparing them, particularly the upper portion of Plate I., fig. 8, with Plate C., fig. 19; and, in like manner, the sands and gravels of Plate I., figs. 4, 5. with the sandstone and conglomerate of Plate C., fig. 20. These Plates are mutually explanatory of each other, and prove that both detritic sands and gravels, and the older sandstones and conglomerates have had a similar origin, and been subject to similar variations in the forces producing them, the periodical or even the casual augmentation of the velocity of the stream or current disturbing the quiet course of the deposit, and introducing beds of gravel, the form and arrangement of which are again modified by local obstructions producing eddies and the consequent accumulation and contortions of the beds.

The detritus of the White Water and the Moyola is further remarkable for the consolidation of its beds by calcareous matter deposited by water in its passage through them. This is so complete that the gravel becomes a hard conglomerate, and wearing less rapidly than the clayey beds below, projects as a rude cornice beyond them. When broken off, this recent conglomerate falls in large fragments, which resist decomposition for a considerable time. The surface of the detritic beds are not always even; they are sometimes minutely waved or furrowed, and occasionally more deeply furrowed, as in fig. 7. In this instance, the underlying gravelly clay was hollowed out, as if by a stream or retreating tidal current, and the excavation was subsequently filled by gravel and covered by layers of fine sand and gravel, which gradually lose their conformability to the hollow in the clay. Here, then, is distinct evidence in the detritic deposit of a considerable lapse of time, as well as of a variety of operations; for although the bank of gravelly clay may have been accumulated by a single process, the exact nature of which could only be determined by a knowledge of the condition of the earth's surface at the time, the wear of that bank and the deposition upon it of alternating sand and gravel, seem to require a totally different description of agency. Tamlaght Finlagan, from which this example is taken, is very rich in interesting sections: the detritus appears to be arranged parallel to or resting against the schist ridges in an east or west direction, and is cut through by the streams making their way to Lough Foyle in a generally north and south direction, so that the hollow, of which fig. 7 is the section, if continuous, must have been parallel to the present shore line; that line may not indeed represent the ancient shore line; but if the two were parallel to each other, such cases are not unusual along our present shores, in which the wear is influenced by the deflection of currents from local obstructions. The visible depth of these deposits is variable;

in the White Water it is about sixty feet, and in Tamlaght Finlagan from thirty to forty; but they are not confined to valleys or to the base of hills, as similar alternations of sand and gravel have been noticed wherever wells have been sunk. Mr. Irwin's well, in the flat of Balteagh, is only ten feet deep; the water stands at two feet six inches, and in sinking, a layer of sand was found to be interposed between two layers of gravel. Mr. John M'Keever's well is forty-five feet deep, the water stands at thirty feet, and the successive beds passed through were sand six feet, clayey gravel three feet, clay six feet, and then sand and gravel, the pebbles of which were large, many exceeding one foot in diameter. Such examples would be multiplied by attention to the sinking of wells, and in general water would be found on arriving at the pebbly or gravelly clay, underlying the sand and gravel. Along the south shore of Lough Foyle several distinct steps may be traced in the detritus: through the more marked of these flats the Roe pursues a very winding course, occupying a comparatively narrow space within a wider excavation, bounded by retired detritic banks, and as the minor streams are similarly circumstanced, the detritic plain, near Newtown Limavady, is singularly scooped out into winding channels and basin-like hollows. Following the line of detritus from the Roe to the Foyle, the gravel is accumulated at Faughanvale, where it appears to have been heaped up against a projecting spit of the schists, at the hill over which the old road passed to Muff; and the gravel hillocks, which bound the Loughs Enoch, are of a similar description and origin. The detritic flat, with its alternating beds of sand and gravel, is repeated inland at higher elevations, and is also accompanied by occasional accumulations or banks of either gravel or sand. In the parish of Upper Cumber both these characters of detritus may be studied to advantage, and the latter one also in the valley, extending from that parish through Banagher to Dungiven. On the road from Claudy to Park, the streams are observed to have cut their channels into sandy detritus; but at Rosses Bay and at the Bin near Claudy, on the right bank (ascending) of the Faughan, is the most beautiful illustration of this class of detritus, as represented in the woodcut. Here there is a gap or cut in the bank, which extends for about two hundred yards, into a perfectly regular deposit of sand. The sand is forty or fifty feet deep, and divided into layers by thin partings of clay, and occasionally by a thin layer, two inches thick, of pebbles, from one to four inches in diameter. The pebbles in these layers are principally of schist, which are flat, and quartz, and there are also red sandstone, Crohan porphyry? and rarely granite. The sand itself is extremely fine and free from pebbles, and when undermined by the softening and removal of the clay partings, is poured down like an avalanche of snow, as shown in the woodcut. It is capped by twelve feet of gravel, and that again surmounted by four feet of bog. Nothing can be more beautiful and regular than this deposit.

No. 25.



Not less interesting, and still more difficult of explanation, are the deposits which occur at still higher elevations and in more isolated positions. On the Stranagalwilly, several such are noticed at the bends of the river, and are so steeply scarped as to look like pinnacles of sand; they extend to an elevation of nearly one thousand feet. In Banagher and Dungiven, the hills are thickly covered with detritus to about the same height; and it may be asked, are these isolated pinnacles or hills only the last relics of a deep bed of detritus, nine hundred or one thousand feet thick, which has been worn away and gradually moulded into their present forms, or are they heaps or banks, accumulated from local obstructions, and then subjected to a modifying aqueous agency? In either case, they appear to have some relation to the physical features of the country, the more general altitude of the sand and gravel conforming nearly to the height of the dividing ridge between the counties of Derry and Tyrone; whilst some of the deposits, as the hill of Derrynaflaw, near Dungiven, and the sand and gravel hills along the Faughan (for example, near the Oaks) are evidently related to the present valley configuration of the surface. Independently indeed of the evidence derived from their own form and position, the deposition of tertiary clays which underlie the gravels has shown that the basin of Lough Foyle must have possessed its present bay-like character at a very remote epoch; and yet there is reason to believe that a similar, or schist, detritus had been spread over the surface at a time when the boundary cliffs of the bay were still submerged, as on ascending the steep sides of Benyevenagh fragments of quartz and pebbles of mica schist are found in the beds of the small streams, mixed with chalk and trap pebbles, and continue nearly to the summit of the mountain. It is not necessary that these pebbles should have moved over the flat (Plate B.), as the schistose rocks of the east or south might have supplied them; but it is at least requisite that, at the time of their transport, the top of Benyevenagh should have been subject to aqueous action, and that it was so, is proved by the manner in which the successive tabular layers of basalt have been worn away.

In looking at the facts here stated, it may be reasonably deduced that regularity is far more apparent in the detritic deposits described than confusion, and that nothing in them is inconsistent with an origin similar to that of the sands and gravels now accumulating under the influence of existing causes; but it may be asked, are all these causes necessary? Have marine and fluviatile currents, floating ice, and glaciers all contributed to produce this ultimate effect? In replying, as regards this particular district; the fact is important, that its physical configuration was nearly the same when the sands and gravels were deposited as it now is. In some of the detritic deposits there may be noticed a certain amount of confused or violent action manifested in the gravelly clays, through the substance of which large pebbles of one foot in diameter are frequently dispersed; and this form of deposit would, perhaps, be better explained by the action of moving ice, than by simple currents. Again, in the alternating beds of sand and gravel, spread uniformly over large spaces, is seen a variation in the intensity of the moving forces, and a consequently frequent alternation of fine and coarse materials; and, on the whole, these effects seem more consistent with drifts than with the action of ice. In the very fine sand of the Bin and of Rosses Bay, with its clay partings and lines of small pebbles, is seen a quiet and long continued action, probably assisted by the damming up of the channels by ice. The heaping of gravel and sand at higher elevations may also have been aided by similar causes, but at present distinct evidence has not been obtained of the action of land ice, or glaciers.

A very brief notice only will now be taken of other detritic localities, as the subject requires, for its perfect elucidation, the detailed examination of all the northern counties. Along the southern margin of the old red sandstone district, near Ballygawley, the ridges of gravel run from north-west to south-east, are worn into rounded forms, and when cut through exhibit the usual alternations of sand and gravel; many of them may have been originally combined, and separated by subsequent wear, the present direction of the ridges indicating that of the modifying, not of the depositing currents. Of the masses of detritus, near Pomeroy, the same remark may be made, the deep gashes which now separate them having been formed subsequent to their original deposition; and the sand and gravel of Donaghmore, Desertcreat, and Desertmartin, in Derry, have been similarly moulded into their present forms, though, in the latter cases, the action does not appear to have been violent, but from the tortuous character of the channels between the hills to conform to the bay-like character of their positions. Analogous to the elevated sand deposits of Stranagalwilly, in Derry, are the equally raised masses which are heaped up on the elevated flat, at the base of Slieve Gallion, near Lough Fea; they appear to be of great depth, and their accumulation at so high a level is the more remarkable, as much of the lower ground of Lissan and Kildress is less encumbered with detritus. In the eastern parishes of Derry, along the course of the Bann, the form of Detritus is peculiar and beautiful, it appears like so many streamers attached to each basaltic knoll, and directed from north to south, the pebbles of the gravel being principally local or basaltic. These results of a current, setting in from the north and having somewhat of a fluviatile or channel character, are never lengthened out into the narrow continuous escars of the west of Tyrone, which were most probably due to extended marine drift. It would be a vain attempt to bring home to the mind the forms of lake-like expansions or basin-like hollows, as those of the Moyola and Garvagh, or the rounded knolls which so often occur in the openings of existing valleys, even on the higher ground or at the junction of streams; they are striking evidences of aqueous action, similar to that now in operation, but could only be made palpable to the senses by sight, or by numerous detailed drawings.

Of boulders it is unnecessary to speak in much detail: the only efficient cause by which they could have been moved over ground of every form and height, and still retain their angularity, seems to be floating ice. In this district numerous examples might be cited of blocks of very large size. Those of granite are abundant in the north of Derry, are generally about four or five feet in diameter, much rounded, and deposited on the gravel in comparatively low situations; these, it is most probable, came, as before stated, from Donegal. On the east of Derry, in Ballynascreen and Maghera, granitic boulders disappear. On the south and east of Tyrone, they again occur; they have here had their origin in the granitiform rocks of Slieve Gallion and the adjacent district. On the higher grounds, and even on the summits of gravel-covered hills of considerable height, large blocks of gneiss and mica schist are common, which, though of more local origin, must have been moved in a similar manner from their original position. Some of these are of enormous size, varying from five to eleven, fifteen, and even more, feet in diameter; but it is useless to enumerate localities, as every inquirer must necessarily meet them. It is, however, right to observe that their almost unavoidable connection with the action of floating ice, is not merely important as regards their own distribution, but also in proving that glacial action of every other kind may reasonably be assumed to have co-operated in producing the present configuration of detritic deposits.

To form a correct basis for reasoning on this interesting subject, two preliminary inquiries are necessary,—the one into the actual character of the rocks, and the other into that of the detritus,—as without them no one could determine, with accuracy, whether the deposits were local or foreign, were brought from a near or distant locality. In Chapters VII. and XI., this inquiry has been attempted in respect to rocks; and, in the table of gravels (see appendix, p. 747) it is extended to the detritus.

ECONOMIC GEOLOGY.

No. I.

MINERAL SPRINGS.

THE connection of mineral springs with the strata in which they occur, is necessarily so intimate, that they possess, even on that account, a geological interest. Within the great schistose area ferruginous springs are abundant, sometimes occurring in the schists, and at others in the detritus; and in a similar manner they are not unfrequent in sandstone districts, where oxide of iron is also an abundant ingredient. On passing the boundary of such formations, and entering on the carboniferous shales, where pyrites and carbonaceous matter abound, sulphuretted hydrogen becomes the characteristic ingredient, and may be observed under such circumstances in Tyrone at the spa well near Ballygawley; in the county of Fermanagh, in the little stream in the parish of Drumkeeran, townland of Bannaghmore, where the spring has the singular appearance of issuing from a dyke which there traverses the shaly strata; in Cavan, at the well known spa of Swadlinbar, and in many other localities, of which the spa of Lucan is perhaps the best known. The strata, therefore, which have supplied the mineral ingredients to these springs are usually near the surface, or at least not so far from it as to affect materially the temperature, and the water would also seem, as a general rule, to have a temperature not corresponding to any great depth below the surface, as will be seen by reference to the table of temperature of springs, where the degree of heat corresponds nearly to that of the surface of the earth. The peculiar simplicity of the composition of springs in the schistose district is shown by Professor Kane's tabular view of the waters submitted to his examination, and it is evident that they bear a strict relation to the rocks within the range of which they occur. The subject, which, I trust, will hereafter be more fully elucidated, is one of considerable interest, and I have thought it therefore the more desirable to give Professor Kane's remarks and suggestions in his own words:—

REPORT on the NATURE of the SPECIMENS of MINERAL WATERS, received from the Geological Department of the Ordnance Survey, by Professor R. J. KANE, M.D.

These specimens, with the exception of two, would only permit qualitative examinations to be instituted. The peculiar simplicity of their composition, however, rendered it unnecessary to operate on larger quantities, and I believe that the statements exhibited in the accompanying tabular arrangement, will be found satisfactory.

Of thirty specimens twenty-three contained oxide of iron, some in considerable quantity, particularly the waters from Creevedonnell (R. Marshall), and from the spa well of Ardinarive. In all these, the iron was completely separated as peroxide, but in the case of the water from Ardinarive, it was expressly stated to have been dissolved. This spring I consider well deserving of an accurate quantitative analysis, as from the quantity of peroxide of iron that had separated in so small a specimen, it is probably not undeserving of its popular reputation of a chalybeate spring. For a satisfactory analysis a gallon of the water should be operated on.

When separated from the iron deposits, these waters are remarkably pure, their specific gravities being exceedingly low. There were only eight specimens of sufficient volume to allow of an accurate determination of their densities. Of these waters containing iron, one from Glenconway had the highest density =1000,44, and one from Enagh, the lowest=1000,05.

The water from Toel's Well containing much iron, and the specimen amounting to about 12,000 grains, I made a quantitative analysis of 10,000 grains, in order to illustrate the nature of the impurities of the other waters, of which I consider this one may fairly be considered a type. The details of that analysis are subjoined to this report.

The impurities generally indicated as being present in these waters are sulphuric, carbonic, and muriatic acids, soda, lime, and oxide of iron. The sulphuric acid exists in very small quantity, as likewise the muriatic acid. The lime is found only in minute quantity, and principally exists as carbonate, hence all these waters belong to the popular class of soft waters. In twenty-three specimens the iron constituted the most important foreign matter. I did not isolate magnesia in any but the water from Toel's Well, and then only in course of the quantitative analysis. I consider, however, that on examining large quantities of these waters, that earth would be found probably in many, it being generally associated with lime, which exists in most of those examined. Of the waters in which the presence of lime is not indicated in the tabular view, I believe that the want of action of the re-agents arose in many cases from the small quantity of water tested, in many cases not one ounce, in most not exceeding two ounces. In order to apply re-agents in a satisfactory manner, about a pint of the water should be evaporated to a fourth part, which would increase the delicacy of the indications in a corresponding manner.

In marking on a geological or other map the position of a spring, it may be thought useful to possess a method of giving in a short formula, a general idea of the nature of its ingredients. This can be readily effected by adopting, to express the names of foreign matters, the symbols now universally adopted in chemical notation, and so to connect them in position as to indicate their relative importance.

To describe the mineral nature of a water, three matters appear necessary to be determined. 1st, The density, from which may be pretty accurately ascertained the per centage of solid matter; 2nd, the general nature of the foreign matters; and 3rd, the nature and amount of the characteristic ingredient. For a complete description it would be necessary to give the quantities of all ingredients, but for all useful purposes, in cases where the springs do not deviate very much from ordinary circumstances, the quantity of the characteristic ingredient alone need be given.

If, on the position occupied in the map by the spring be written the word spring, and then the number which should be added to 10,000 to give the density of the water, then on the same line the symbol of the characteristic ingredient, and the quantity of it in 10,000 grains of the water, and on a second line be written the symbols of the other ingredients, there would be given very briefly a general idea of the nature of the water sufficiently accurate to point out its application to medical or economical purposes.

Thus to describe the water of Toel's Well, there should be written—

$$\text{Spring. } 22.\ \dot{\text{F}},\ 099$$

$$\dddot{\text{S}}.\ddot{\text{C}}.\,\text{Ch H}.\dot{\text{Na}}.\dot{\text{Ca}}.\,\dot{\text{Mg}}$$

22 being the number to give the density 1000·22, and 10,000 grains of the water containing ·099 grs. of protoxide of iron; for although the product obtained by analysis is peroxide, yet the iron in such waters exists as carbonate of the protoxide, and is completely separated from the liquid when it becomes peroxidized by exposure to the air.

The remaining symbols are those of the usual chemical notation, thus, $\dddot{\text{S}}$. sulphuric acid, $\ddot{\text{C}}$. carbonic acid, Ch H. muriatic acid, $\dot{\text{Ca}}$ lime, $\dot{\text{Na}}$ soda, $\dot{\text{Mg}}$ magnesia. In other waters some additional formula should be introduced, as SH for sulphuretted hydrogen.

If there were two ingredients which together gave to the water its characteristic property, the symbols of these bodies should be both placed on the upper line. Thus the water from Gortin, which contains sulphuretted hydrogen and oxide of iron, should have

$$\text{Spg. } 43.\ \dot{\text{F}}.\ \text{SH}.$$

$$\text{Ch H}.\ \ddot{\text{C}}.\ \dot{\text{Ca}}.\ \dot{\text{Na}}$$

In cases where the water did not possess any ingredient very remarkable for its influence or quantity, the place of the characteristic matter should be unoccupied, as in the instance of the water from Mr. Jameson's spring at Stradreagh, which may be written

$$\text{Spg. } 21.\text{———}$$

$$\dddot{\text{S}}.\ \text{Ch H}.\ \dot{\text{Ca}}.\ \dot{\text{Na}}$$

It would not be difficult to devise other means of representing the general nature of springs, but the above seems to me to supply the most useful indications.

Robert J. Kane.

REPORT of ANALYSIS of WATER from Toel's Well, Ballycallaghan

Density at 60°=1000,22.

A. Ten thousand grains evaporated to dryness left residue 1,43 grs. This digested in alcohol gave a clear solution, which was dried, and the residue dissolved in water. From this nitrate of silver threw down a chloride which gave the muriatic acid. The liquid contained no lime or magnesia. The muriatic acid had been completely combined with soda.

B. The residue, insoluble in alcohol, was digested in boiling water as long as anything was taken up. The solution, treated by nitrate of barytes, gave sulphate of barytes, by nitrate of silver, gave chloride of silver, and by oxalate of ammonia gave oxalate of lime. After the separation of these bodies, the application of ammonia and phosphate of ammonia gave a deposit of the ammoniaco-magnesian phosphate.

C. The matter insoluble in water dissolved completely in muriatic acid, the solution neutralized gave, by oxalate of ammonia, oxalate of lime, and then by ammonia, peroxide of iron. From the peroxide the quantity of protoxide was estimated, and the quantity of carbonic acid assumed as that necessary to transform this second portion of lime and the protoxide of iron into carbonates.

The result for 10,000 grains of water is as follows:—

Sulphuric acid,	B		0,177
Carbonic acid,	C		0,371
Muriatic acid,	A B	0,127 0,038	0,165
Oxide of iron,	C		0,099
Soda,	A B	0,108 0,033	0,141
Lime,	B C	0,126 0,159	0,285
			1,238
	Loss,		0,192
			1,430 grains.

There existed a trace of magnesia.

ROBERT J. KANE.

Sulphuric acid and sulphuretted hydrogen will be both noticed in the following table, as an occasional constituent of the mineral waters, a circumstance which naturally results from the frequent occurrence of crystals of iron pyrites in the schists. They do not, however, form the characteristic principles of the waters as in the springs of districts where carboniferous shales or impure limestones prevail.

Tabular View of the Constitution of Mineral Springs, examined by Professor R. J. Kane, M.D.

Locality of Spring.		Density.	Impurities, &c.	Remarks.
Ballyarnet	Templemore	1000,29	Sulphuric, Muriatic, and Carbonic Acids, Soda, Lime, and Oxide of Iron	
Carrowreagh	Tt. Finlagan	Not taken	Sulphuric, Muriatic, and Carbonic Acids, Soda, Lime, and Oxide of Iron	
Ib.	Ib.	1000,36	Muriatic and Sulphuric Acids, Soda, Lime, and Oxide of Iron	(Mr. Porter)
Enagh	Clondermot	1000,05	Muriatic Acid, Soda, and Oxide of Iron	
Carrowreagh	Tt. Finlagan	Not taken	Sulphuretted Hydrogen, Muriatic and Carbonic Acids, Soda and Lime	
Shantallow	Templemore	Not taken	Muriatic and Sulphuric Acids, Soda, Lime, and Oxide of Iron.	(Mr. Lloyd)
Ballymagrorty	Ib.	Not taken	Muriatic Acid, Lime, and Soda	
Ballymagalliagh	Ib.	Not taken	Muriatic and Sulphuric Acids, Soda, Lime, and Oxide of Iron	(Mr. O'Dogherty)
Gortin	Clondermot	1000,43	Sulphuretted Hydrogen, Muriatic and Carbonic Acids, Lime, Soda, and Oxide of Iron	
Enagh	Ib.	1000,43	Sulphuric and Muriatic Acids, Lime, Soda, and Oxide of Iron	
Bogagh	Ib.	Not taken	Sulphuretted Hydrogen, Muriatic and Carbonic Acids, Lime, and Soda	
Knockbrack	Ib.	Not taken	Muriatic and Sulphuric Acids, Lime, Soda, and Oxide of Iron	
Gortin	Ib.	Not taken	Sulphuric, Muriatic, and Carbonic Acids, Lime, Soda, and Oxide of Iron	(Mr. Stephenson)
Creevedonnell	Ib.	Not taken	Sulphuretted Hydrogen, Muriatic, Carbonic, and Sulphuric Acids, Lime, Soda, and Oxide of Iron	(R. Marshall)
Curryfree	Ib.	Not taken	Muriatic, Carbonic, and Sulphuric Acids, Lime, Soda, and Oxide of Iron	(Mr. Hamilton)
Creevedonnell	Ib.	Not taken	Muriatic, Sulphuric, and Carbonic Acids, Lime, Soda, and Oxide of Iron	
Lissahawley	Ib.		Sulphuric and Muriatic Acids, Soda, and Oxide of Iron	(Near Enagh Lough)
Enagh	Ib.	Not taken	Muriatic and Sulphuric Acids, Soda, and Oxide of Iron	(Rosse's Bay)
Bogagh	Ib.	Not taken	Sulphuric and Muriatic Acids, Soda, Lime, and Oxide of Iron	(Mr. Wilson)

Tabular View of the Constitution of Mineral Springs, examined by Professor R. J. Kane, M.D.—*continued.*

Locality of Spring.		Density.	Impurities, &c.	Remarks.
Derryard	Bovevagh	Not taken	Muriatic, Sulphuric, and Carbonic Acids, Soda, and Lime	Tubbernacush
Coollessan	Drumachose	Not taken	Muriatic, Carbonic, and Sulphuric Acids, Soda, Lime, and Oxide of Iron	(Banks of the Roe)
Glenconway	Bovevagh	Not taken	Muriatic and Carbonic Acids, Lime, Soda, and Oxide of Iron	(New Lime Quarry)
Ib.	Ib.	1000,44	Muriatic and Carbonic Acids, Lime and Soda, and Oxide of Iron	(Old Lime Quarry)
Gornaran	Upper Cumber	Not taken	Muriatic and Carbonic Acids, Soda, Lime, and Oxide of Iron	
Ballycallaghan	Ib.	1000,22	Muriatic, Carbonic, and Sulphuric Acids, Lime, Soda, Oxide of Iron, and Magnesia	Toel's Well—See Quantitative Analysis
Ardinarive	Bovevagh	Not taken	Muriatic and Carbonic Acids, Soda, Lime, and Oxide of Iron	Spa Well
Drumaderry	Aghanloo	Not taken	Muriatic and Carbonic Acids, Lime, and Soda	Mr. Jameson's Near Old Mill, about 200 yards south of Public-house
Stradreagh	Clondermot	1000,21	Muriatic and Sulphuric Acids, Lime, and Soda	
Mr. Ogilby's	Dungiven	Not taken	Muriatic and Sulphuric Acids, Lime, Soda, and Oxide of Iron	
Aughlish	Banagher	Not taken	Muriatic and Sulphuric Acids, Lime, and Soda	

The frequent occurrence of free sulphuric and muriatic acids in the waters of these springs explains the cause of those apparently noxious qualities, which are sometimes exhibited by the clays and tills when applied, immediately on being dug up, as a dressing to the land. A blue clay of this description was tried by Major Scott of Willsborough, and proved very injurious, when, on examination, it was found to contain the proto-muriate of iron, which has an acid reaction. Such a clay should be exposed to the air before being applied to the land, so as to peroxidise the iron, and either mixed with lime, or at least sprinkled with lime dust, on each successive layer of the heap, to neutralize the free acids, and it would then become as beneficial on peaty or sandy soils, as it had before been injurious.

The ferruginous matter of these springs, though originally dissolved in the water as a carbonate, is not, when found deposited, a mere mineral oxide. The change it has undergone is well known to men of science from the works of Ehrenberg; but it may not be uninteresting to state here, that it has become organic. The process appears to be this: the carbonic acid holds the protoxide of iron in solution, the iron becomes peroxidized, and the carbonic acid escapes, when a new or vital force comes into action, and the matter is seized upon by infusoria, and becomes part of the organic structure. The principal agent is the Gaillonella ferruginea (Ehrenberg) but in all the specimens I have examined, I have never found them perfect or fully exhibiting the characters assigned to that species. They appear like fragments of rigid or hollow tubes or springs, which are twisted together in such a manner as to form the ferruginous floccy matter which floats on the surface or is deposited on the banks. To see them distinctly as hollow tubes, a magnifying power is required of upwards of 200 diameters.

This deposit of the peroxide of iron is seen to great advantage along the banks of the small streams which traverse the boggy flat on the boundary between the counties of Derry and Tyrone (noticed in Chapter XI., page 531), where it has been so copious that the animal forces were not sufficient to appropriate the whole, and to impress upon it an organic character. A considerable quantity has been thrown down as a hard ochraceous crust, or bog iron ore, the upper or less consolidated portion of which is yellow, about an inch thick, and underlies the bog along the streams, where every vegetable filament is coated with the ochreous sediment, the yellow feathery bundles waving with the motion of the water to and fro, from the margin of the bank to which they are attached, in a very graceful and curious manner. The coating of these filaments is the Gaillonella, which may possibly be secondary in origin to the ochreous crust under the bog. The hard red till, which forms so troublesome a subsoil in the schistose district, is another result of the ochreous deposit, and would be much diminished by draining and deep ploughing.

The low temperature of the springs, as detailed in the table on the following page, is accompanied by a curious example of vital adaptation to peculiar circumstances. Several of the springs, some even at considerable elevations, are crowded with living Lymneana, which may be scooped out in a basin in considerable quantities, thus affording another proof that life is everywhere, and that depression of temperature is not unfavorable to the full development of the animals of this family of Trachelipoda. Sudden changes of temperature are injurious, but a low, if uniform, temperature seems in this, as in other recorded instances, quite compatible with the full exercise of the vital functions, and even with an extraordindary multiplication of the individuals of a species.

Temperature of Springs.—Derry and Tyrone.

Date.	Parish.	Townland.	Temp. Air.	Temp. Water.	Depth in Water, Inches.	Time left in Water, Minutes.	
1838	DERRY.						
Feb. 1	Low. Cumber	Gortinreid	35°	44° 30′	3½	2	
" 6	"	"	32° 45′	44° 45′	4	5	
" 3	Faughanvale	Glassakeeran	29°	39°	–	5	
" 4	"	Boundary of Tirmacoy & Barnakilly	32°	38°	3	4	
" 3	Low. Cumber	Gortinreid	30° 30′	45°	–	3	
" 4	Faughanvale	Tirmacoy	31° 45′	37°	3	4	
" 4	"	"	32°	36° 45′	4	3	
" 4	"	Bolie	31° 45′	36°	3	5	
" 6	Low. Cumber	Boundary of Gortinreid and Brockagh	33° 30′	43° 45′	3	5	
June 4	Tt. Finlagan	Glasvey	74°	48° 45′	3	5	
" 4	"	Sistrakeel	67°	58° 45′	4	5	
" 4	"	Glack	67°	47° 45′	4	6	
" 4	"	Drumraighland	60°	52°	3	5	
July 16	Bovevagh	Bovevagh	61°	46°	2	5	
" 16	"	Boundary of Leck and Ardinarive	59°	46° 15′	4½	5	
June 15	Aghanloo	Stradreagh	75° 15′	48°	3	5	
" 15	"	Largantea	79°	47° 30′	4	5	
" 15	Drumachose	Leck	74°	47°	4	5	
" 15	"	Drumramer	64°	46° 45′	4	5	
" 15	"	Ballycrum	59°	46°	3	5	
July 12	"	Carran	67° 30′	44°	4	5	
" 13	Balteagh	Moneyguiggy	57°	46° 30′	4	5	
" 13	"	Cloghan	60°	46° 45′	5	5	
" 13	"	Terrydoo Clyde	66°	46° 45′	4½	5	
1839	TYRONE.						
Oct. 2	Lissan	Dirnan	64° 30′	48°	2	5	
" 2	"	Dunamore	62°	46° 15′	4	5	
" 2	"	Ballybriest	60°	46°	4	5	
" 8	"	"	52°	46°	4½	5	
" 2	"	"	59°	48°	4	5	
" 8	"	"	52°	48°	2	5	
" 2	"	Feegarran	49°	45° 45′	4	5	
" 2	"	"	49°	48°	4	5	
" 2	"	"	46°	48° 45′	3	5	
" 2	Derryloran	"	46°	48° 30′	4	5	
" 3	"	Killycurragh	52°	47°	4	5	
" 3	Kildress	Muntober	49°	49°	4	5	
" 3	"	"	48°	46°	4	6	
" 3	"	Derrinleagh	48°	46° 45′	4	5	
" 3	"	Clare	47° 45′	46° 45′	4	5	
" 3	"	Clontyfeeragh	48°	47° 30′	4	5	
" 3	"	"	48°	48° 45′	4	5	
" 4	Derryloran	Maloon	49°	46° 45′	4	5	
" 4	"	Coolreaghs	52°	48°	4	5	
" 4	"	Monrush	52°	48° 15′	5	8	
" 4	"	Toberlane	49°	48° 30′	5	5	
" 5	Donaghenry	Annaghone	78° 15′	49° 45′	5	8	
" 5			78°	47° 30′	3	6	On boundary of parishes of Artrea and Donaghenry.
" 5	Donaghenry	Sessia Murphy	69°	49° 45′	5	8	
" 8	Lissan	Dirnan	51° 45′	47° 45′	4	5	
" 8	"	Derry	51°	47°	3	7	
" 8	"	Cluntyganny	50° 30′	47°	5	5	
" 9	Desertcreat	Gortavilly	49°	47° 45′	4	5	
" 9	Donaghenry	Sherrigrim	52°	48° 30′	4	6	
" 9	Desertcreat	Donaghrisk	48°	48° 45′	4	5	

No. II.

Climate—Drainage.

Of all subjects of conversation, the weather is perhaps the most engrossing, and in few countries is it so much a subject of complaint as in Ireland. Every one feels, acknowledges, and generally exaggerates the supposed evil; whilst the principal remedy of its practical ill consequences, drainage, is universally neglected. Too much water requires drainage as a corrective, the excess of water being the evil, not the water itself. These remarks I make from the conviction which has often passed over my mind when visiting some of the wilder and more unpromising parts of the country, that the dampness of the climate, under the present rude system of tillage, is a blessing rather than a curse. It induces natural fertility, where without it there would be sterility; and appears to be the reason why soils of indifferent quality are so often covered with a fresh and wholesome verdure, and tracts of mountain or rocky ground which would appear to repel cultivation, are made to produce crops, and to support a considerable population. The wanderer along the mountain side, or in such rocky districts as those of Orritor, Dungate, Craigballyharky, Cregganconroe, &c., will have frequent cause to admire the patience and fortitude with which the humble peasant encounters the apparently impracticable task of clearing away stones, reclaiming bog, and introducing cultivation amidst the rocks; and though he may murmur at the frequent shower, to him so troublesome, he will readily recognise it as a powerful auxiliary to the poor man's labours. A dry climate would require a more perfect tillage to render the soil fitted to absorb moisture: a damp climate forces vegetation in spite of indifferent culture. But if the climate in some degree favors the rude operations of the small farmer, it ought to stimulate him to exertion, by the conviction that were the ground drained and the culture improved the chances of a good harvest would be vastly increased, even in mountain districts, and in the lower and more fertile tracts, where the excess of water has scarcely any counterbalancing advantage, a most serious evil would be removed.

In order to place this in a clear light, I have had the accompanying tables constructed, by which a comparison may be readily drawn between the climate of Ireland and that of England, and the true nature of the Irish climate determined. The first table, contributed by G. Wilkinson, Esq., conveys a good idea of the popular impressions of weather. The great differences in different places and districts cannot be explained solely from localities, and is doubtless, in part, due to the very varying estimates of what is fair and what is wet formed by different people, the intervening column of partly wet partly fine being in consequence either augmented or diminished. This is a strong argument for keeping local registers of the times and quantities of rain, as they would remove ambiguity and prove most valuable practical guides in farming operations. To show this more clearly, the quantity of rain has been classified in Tables 3 and 4, according to quantities which may be assumed to represent certain popular forms of expression, such as fair, light showers or showery, rainy, and heavy or continued rain. The comparison of these tables with Nos. 1 and 2 show at once that the actual number of days of very heavy rain was popularly estimated with tolerable precision; and if the days of no rain and of fair be taken together, their sum 206 in Table 3 is nearly the same as 207 in Table 1, but exceeds considerably that of No. 2, which is 193; on the whole, however, Table 3 conveys at once a fair representation of ordinary estimates of weather, and an accurate statement of what it actually is.

If now the Dublin table be compared with that of London, several interesting results will be at once perceived. In Dublin, the average number of days of no rain is only 150, whilst in London it is 220; but at the same time the number of fair days is less in London, so that the comparison would stand thus:

	No Rain.	Fair.	No Rain and Fair.
Dublin	150	56	206
London	220	10	230
	70 in favor of London.	46 in favor of Dublin.	24 in favor of London.

And in like manner—

	Light Showers.	Rainy.	Heavy Rain.
Dublin	41	94	24
London	33	82	21
	8	12	3

The actual difference of the climate, as to the number of rainy days estimated on six years, is therefore 24 in favor of London, the greater proportion of which falls into the class of partly wet and partly fair, the number of days of very heavy rain being nearly the same. The range of variation in the number of days of no rain was nearly equal in both countries, but combining no rain and fair there was less variation in the climate of Dublin than in that of London.

	No Rain.		No rain and Fair.	
	Dublin.	London.	Dublin.	London.
1837	177	242	216	247
1841	120	188	197	205
	57	54	19	42

The number of days of heavy rain varies from 18 to 32 in Dublin, from 16 to 30 in London; but it is remarkable that the years do not in this respect correspond, 1841 being the year of least heavy rain in Dublin, and 1839 that of the most; 1837 the year of least, 1841 of most, in London; and this difference, consequent on the different local position of the places, is also observable in the actual quantities of rain; for although the amount of variation is nearly equal, 34·826—25·788 = 9·038 in Dublin, 27·372—17·942 = 9·430 in London—the years of the least and greatest quantities of rain are quite different. In the year 1840, the relative quantities at the three places vary more regularly with each other than in any other year; and, in like manner, the monthly tables show that the general character of that year was very similar in London, Dublin, and Belfast, whilst in many other years the relative qualities of the months is very different. The average quantities of annual rain stand thus: London 21·714, Dublin 25·874, Belfast 34·966; but I fear part of the great excess in the latter case is due to imperfection in the mode of determining the quantities, an evil to be regretted, but which, without doubt, will be henceforth remedied. These comparisons might be extended to the temperature, but they can be readily made by any one; and it is only necessary to observe that the monthly means do not vary so much as might be expected, though they indicate a generally colder winter and hotter summer in England. The most important difference of the climate, especially of the North of Ireland, as compared to the midland portion of England, is the excess of rain in Ireland; and it is therefore desirable to ascertain in what portions of the year the evil is most strongly felt. Referring to the averages of No. 8, and combining together the rainy days and days of heavy rain under the appellation of bad weather, and, as before, the days of no rain and fair days under that of good weather, the comparison stand thus:

	Dublin.		London.	
January	good 15	bad 11	good 20	bad 8
February	15	9	17	8
March	18	9	21	7
April	19	7	20	7
May	22	7	22	8
June	17	9	19	8
July	14	13	19	9
August	17	12	21	8
September	18	9	17	10
October	18	10	19	10
November	13	12	15	12
December	17	10	21	8

The months, therefore, which agree best in the two places, are April, May, September, October; whilst July and August, such important agricultural months in the warmer portions of England, are much wetter and more unfavorable in Ireland. The month of March is wetter in Dublin, but there is a reasonable proportion of fine weather: the month of November is wet in both countries, and December continues more so in Dublin than in London.—These comparisons seem to point out distinctly that, if the ground were properly drained, so as to be rapidly freed from superfluous water, spring tillage for late crops might always commence in March, and harvest be expected in September, and that October would be the most favorable month for autumnal tillage for early crops. Of what infinite importance, then, is it to have the ground so drained as to be ready for the fitting moment, and not, as is so often the case, to have the tillage postponed till the ground has slowly dried of itself, and the sowing in consequence postponed till May, the harvest, as a further result, being kept back till the wet weather of November.

As the necessity of drainage is in a direct proportion to the greater amount of rain, and in an inverse proportion to the less number of fine days, the effect it would produce on the agricultural produce of Ireland cannot be over-estimated; the proper times of tillage and harvest would be insured; the soil would be pulverized and ameliorated by being turned up when dry, not left in intracticable clods, as is now too often the case, when broken up wet; the descent of fertilizing water through it facilitated, the ascent of noxious water prevented. These effects of drainage are fully set forth in Professor Johnston's excellent Lectures on Agricultural Chemistry and Geology (pp. 442–450), and its advantages in promoting the health both of vegetables and animals ably illustrated. He observes, "When we consider how great a national benefit this mere preparatory measure alone is fitted directly to confer upon the country, you will agree with me in thinking that every good citizen ought to exercise his influence in endeavouring in his own district, more or less rapidly to promote it. It has been calculated that the drainage of those lands only which are at present in arable culture (ten millions of acres), would at once increase their produce by ten millions of quarters of the various kinds of grain now grown upon them; and that a similar drainage of the uncultivated lands (fifteen millions of acres), would yield a further increased produce of twice as much more. This increase of thirty millions of quarters is equal to nearly one half of our present consumption of all kinds of grain, so that were it possible to effect at once this general drainage, a large superfluity of corn would be raised from the British soil;" and again, "Not only is this drainage equivalent, as above stated, to a change of climate in reference to the growth and ripening of plants, but it is so also in reference to the general health of the people, and to the number and kind of the diseases they are observed to be exposed to;" and this truly important result of the farmers' labours is confirmed by a reference to Dr. Wilson's paper in the twelfth volume of the Quarterly Journal of Agriculture, where it is stated that in the district of Kelso, within a period of ten years, fever and ague, which had before formed nearly one half of all the diseases of the population, had almost disappeared in consequence of the general extension of efficient drainage, and the fatality of disease, or the comparative number of deaths from every hundred cases of serious ailment, had diminished in the proportion of 4·6 to 2·59. What more powerful recommendation could the philanthropist require of an improvement than this, following Professor Johnston's quotation, that it "at once renders our homes more salubrious and our fields more fruitful," and how applicable is it to Ireland, where fever so often prevails, whilst its principal cause is either overlooked or neglected?

In passing hastily through Ireland, the traveller is too often disposed to notice the extraordinary and omit the ordinary; he sees the naked child at the cabin door, and is surprised at its healthy and robust appearance, which is recorded, probably, as a proof of the excellence of potato diet, but he does not enter the wretched habitation and witness the squalid aspects of some, especially of its female inmates. This is not the result of want of drainage alone, it is in part due to mud floors, unwholesome bedding, accumulated filth; but all these causes are aggravated, and in some degree excited, by a damp climate, as a dry bracing air invigorates the human frame and induces exertion, whilst damp air enervates it and induces indolence, that is, a reluctance to make any exertion beyond what is indispensibly required to supply the actual cravings of hunger. These evils of a wet climate may be diminished or modified by effectual drainage, which deserves, therefore, to be classed not merely as a practical but as a moral engine.

The more evident practical benefits are thus stated in general terms by Professor Johnston.

1. It is equivalent not only to a change of soil, but also to a change of climate, both in reference to the growth of plants and to the health of the population.

2. It is equivalent also to deepening of the soil, both by removing the water and by allowing those noxious ingredients to be washed out of the subsoil, which had previously prevented the roots from descending.

3. It is a necessary preparation to the many other means of improvement which may be applied to the land. These benefits

might be even more forcibly expressed in respect to the climate of Ireland, and to the soil of a large portion of its northern district.

1. Drainage, by carrying rapidly away the superfluous moisture, tends to moderate the natural dampness of the climate, by preventing the accumulation of water on or near the surface; and the result of general drainage would be a diminution of the number of partially rainy days, and an approximation to the more regular climate of England.

2. Drainage facilitates deep ploughing: deep ploughing augments the depth of available soil: a deep soil permits a greater absorption of useful moisture and of useful mineral salts or organic matter before the filtering water arrives at the drains, and is carried off, a magazine being thus formed at the bottom of those useful elements which have been carried through or abstracted from its top, and a reservoir formed of wholesome, not rotting water, to supply the plant for a longer time with refreshing moisture in times of drought; in other words a shallow soil is either saturated or parched.

3. Drainage facilitates the descent of water; hence mineral compounds, such as the protoxide of iron, are either diffused equably through the soil and reduced to a useful, or at least a harmless condition, or are carried away by the drainage without forming those hard ferruginous compounds called till, so common in all the schist district, and so injurious as an impervious subsoil: it should, however, be here remarked that the great abundance of that mineral compound renders a good flow to the drains necessary to prevent such accumulations as those which so often fill up water pipes, as may be seen in those of the city of Derry.

4. Drainage, in the words of Dr. Madden, "alters the direction of the currents which occur in wet soil; for whereas in undrained soil, the currents are altogether from below upwards, being produced by the force of evaporation at the surface, and consequently the spongioles of the plants are supplied with exhausted subsoil water; when land is drained, the currents are from the surface to the drains, and the roots are consequently in this manner supplied with fresh aerated water."

5. Drainage and deep ploughing produce a deep soil: a deep soil is, in some respects, equivalent to an extended surface, the bottom being ready to be exposed to the air, and made use of when the top has been exhausted, a principle applied to practice in the agriculture of Hofwyl.

The benefits of thorough drainage being manifestly so great, it may seem surprising that it should be neglected; but here there is a reason always ready to be advanced, namely, "want of capital," and it may not be without advantage to inquire into the justice of the plea. Few words have led to more practical evil, by causing indolence or repressing energy, than "want of capital." The word capital is seldom understood, but defining it as the power of commanding labour, it becomes a term of easy application. If the work to be performed is one requiring the labour, or the produce of the labour of many individuals, capital is necessary to command it. If it be one within the labour of an individual, capital is unnecessary. Applying this test in the present case, the drainage of an estate is a great work, requiring the labour of many persons, and capital is therefore indispensable; the drainage of half an acre is a work requiring the labour of a single individual, and capital is therefore unnecessary. To illustrate this subject, Tables 9 and 10 have been reduced to Irish measure from the tables of Mr. Smith, of Deanston. Mr. Smith assumes that the landlord should bear the expense of cutting, furnishing, breaking, and filling in of stones, and turfing, as his proportion of a charge tending to the permanent improvement of his property; the farmer all the horse and cart work; and, in like manner, when tiles are used, that they should be supplied by the landlord. But without insisting on that point, and only requiring on the part of a tenant holding tolerable land an imitation of that labour which is so readily applied to reclaim rocky and boggy ground, and on the part of the landlord forbearance, to permit the tenant to benefit by the improvement he has effected, it is clearly within the power of the individual to drain, not at once, but by degrees, his small holding. For example, Mr. Smith recommends drains, the bottom of which are kept open for the flow of water by being filled with loose stones, either broken up for the purpose, or collected from the surface of the field, and this mode would be applicable in the schistose district, and with the exception of those portions of the old and new red, where either clay or fine sand prevails, would be also applicable in the secondary districts, and be useful in clearing away stones. They should be reduced, according to Mr. Smith, to the size of a hen's egg. Referring now to the table, the cost per acre on a sandy clay subsoil, and with a distance of 18 feet between the drains, is £8 10*s.*, a cost, which though estimated upon a higher priced labour than that of Ireland, may be assumed correct, as the excess is probably compensated by increased skill in the operations. If one half of an acre be undertaken as the year's task, it may be thus estimated:—Total cost £4 5*s.*, of which £1 8*s.* 4*d.* is to be charged against the horse and cart employed in collecting and drawing stones, and £2 16*s.* 8*d.* remains as the cost of labour in breaking stones, cutting, filling, &c., which is equivalent to 68 days, at 10*d.* per diem. Any farmer, therefore, may thorough drain half an Irish acre on a sandy-clay bottom, the drains being 18 feet apart, by eight days' labour of horse and cart, and sixty-eight days of manual labour supplied by himself or by his family. This estimate would in practice be greatly diminished, as many of the stones would not require to be broken, and in many cases the drains might be left much wider apart. Where no family help can be obtained, the farmer, as a beginning, may content himself with draining a quarter of an Irish acre, equivalent to four-tenths of an English acre, by the application of four days' labour of horse and cart, and thirty-four days of his own labour; and even this might be facilitated by commencing with wider drains, and interpolating others afterwards.

But, though it is possible for the small farmer even unaided, to drain his land slowly, it would be more reasonable to expect that he should do so rapidly and efficiently by the encouragement, example, and assistance of his landlord. Assistance may be rendered in several ways, by instruction through an experienced agriculturist, by the loan of properly constructed draining implements, and by advances of money or remission of rent in proportion to the work done. Two examples can be here cited of such active and liberal exertions to promote draining amongst the tenantry. The first is that of the Marquis of Waterford, who, through his agent, J. B. Beresford, Esq., has commenced in his northern estate an active system of drainage. An agriculturist, Mr. William M'Leish, examines the drains and certifies their efficiency. The Marquis advances money to the tenantry, for this object alone, at five per cent., during the continuance of the lease, relinquishing the principal. Although this system has only commenced, Mr. M'Leish states that 20,000 perches (of 5½ yards each) have been completed by the tenants, 200 acres having been drained, at a cost of about £4 15*s.* per statute acre, or 8½*d.* per perch, for cutting, breaking stones, and filling the drains, which is equivalent to £7 13*s.* 9½*d.* the Irish acre. The drains have been cut 30 inches deep, 12 inches wide at top, and 4 inches at the bottom, filled to the height of 12 inches with stones broken to a size varying from 2 to 3 inches in diameter, and covered with a sod.

Mr. Beresford remarks that the system is "working most admirably," and though the drains were not finished in time to allow a fair estimate to be formed of the benefits which will hereafter be derived from them, it cannot be doubted that they will equal those experienced in other cases.

The Grocers' Company are in like manner endeavouring to advance this, as well as other useful improvements, amongst the tenantry of their estate, and I am indebted to H. Wiggins, Esq., their resident agent, for the following particulars:—

Muff, 7th November, 1842.

Although considerable improvements were made on the Grocers' estate in the years 1837 and 1838, I regret that I have no record of the number of perches of drains and fences, barrels of lime, &c. In the autumn of 1838 the improvements were put under a regular system, the estate being divided into three districts, with an overseer to each, whose duty consists in laying out fences and drains, and measuring and valuing the same when made, the moiety of such value is then entered in a cheque book, and a duplicate given to the tenant, who presents it when paying his rent, and is allowed the amount, not exceeding 10 per cent. on the rent, any excess being carried to the next year's credit. I send you the form used by the overseers.

The result of the three years sent herewith will show the very great improvement rapidly taking place in the condition of the land. From my own observation I am persuaded that the increase of produce on the estate within the last five years, is from 20 to 25 per cent. The accounts of improvements for the present year are not made up; but the fences and drains must equal the amount made in any former year. The tenants particularly find the very immediate benefit arising from draining, and are following it with perseverance. The lime and shells also act much better on land that has been drained; the sorrel and other sour weeds incident to wet land disappearing, and good natural pasture grasses occupying their place, immediately on the application of the calcareous matter. The use of the shells as manure is somewhat decreasing, as they are only found beneficial on bogs newly broke, or stiff clay lands, which they open, and render friable. The lime is found to consolidate loose over-worked land, and entirely to renovate its powers. New lines of road are now being opened by the Grocers' and Fishmongers' Companies through Slaughtmanus, and also by Mr. Ashe through the glebe land, which will give us a further supply of this valuable manure.

HENRY WIGGINS.

IMPROVEMENTS to LAND in FENCING, DRAINING, and LIMING, made by the Tenants on the Estates of The Worshipful Grocers' Company, in the County of Londonderry, during the years 1839, 1840, and 1841.

PARISHES.	1839.				1840.				1841.			
	Fences, Perches.	Drains, Perches.	Barrels Lime, 32 Gallons.	Amount allowed by Landlord, being one-half the cost.	Fences, Perches.	Drains, Perches.	Barrels Lime, 32 Gallons,	Amount allowed by Landlord, being one-half the cost,	Fences, Perches,	Drains, Perches,	Barrels Lime, 32 Gallons,	Amount allowed by Landlord. being one-half the cost,
Faughanvale .	4964	2976	800		2278	2027	490		2818	4705	1095	
Clondermot .	2300	2338	1200		1037	1193	2516		1880	1894	2091	
Lower Cumber	3900	1559	467		1651	1689	269		2156	2658	535	
Total . .	11164	6873	2467	£550	4966	4909	3275	£410	6854	9257	3721	£496

Besides lime, there was also delivered to tenants at the shore shell manure at landlords' cost, at the rate of 2*s*. per barrel of 9 cubic feet; 9250 barrels, in 1839, 7200 barrels, in 1840, 6000 barrels, in 1841, all of which was spread on newly broke bog land at the rate of from 40 to 60 barrels per acre.

The mode of conferring these beneficial aids by the Company is regulated by direct covenant in the leases, which are thus worded:

"And for the better encouragement of cultivation and improvement upon the said farm by the said tenant, the said Company are willing to make him the allowances following, namely, the sawn timber scantlings for the roofs and floors, and ready-wrought doors and windows (unglazed), and slate (or tile) for covering, and verges and ridges for roofs, and the bricks for the chimney shafts and openings, and lime for the walls of such new buildings as may be first approved by the agent's certificate under his hand; and also timber, bricks, lime, and slates (or tile), for such repairs of buildings as the agent may certify under his hand as proper; all such timber, bricks, slates, tiles, and lime, so allowed to be used within one month after delivery, in such manner as the agent may approve, or, if he shall disapprove, in writing, within three months after such delivery of the use or non-use thereof, then the said tenant shall be charged with the value thereof in his rent account; and also to allow the said tenant poles for gates or bars for such stone gate piers built, or oak or bog deal posts set up by him, as the agent may approve; and also for ——— barrels of lime yearly (each barrel being six Winchester bushels, or 48 gallons of slacked lime), after the rate of 4*d.* per barrel, or for so much thereof as may be proved to the satisfaction of the agent to have been *bonâ fide* laid out and spread as manure upon the land; and also for ——— perches (statute) of French drains yearly, after the rate of 4*d.* per perch, or otherwise draining tiles for such drains, in lieu of the said 4*d.*, provided that such drains be cut and made to the agent's approbation; and also the full value of all such bounds ditches made by the said tenant as the agent may approve, not exceeding one shilling per perch; and also half the value of all such interior ditches and fences as the agent may approve, such half value not to exceed sixpence per perch; and also quick or furze seed for the said fences, such allowances for lime, drains, and fences, not to exceed the sum of ——— in any one year."

The Fishmongers' Company, though not so directly turning its attention to this important object, has manifested an equal desire to promote general improvement, and in respect more especially to the establishment and government of its schools, has experienced the most encouraging success. Arthur Sampson, esq., the agent of the Company, has contributed the following brief account of the nature and progress of the more general improvements, and a detailed statement of the rules and condition of the schools:—

In the year 1820, the Company resumed possession of their property, which, from the year 1612, (the date of their grant), had been demised on long leases to different parties at little more than a quit rent. They found the lands on a great proportion of their estate occupied by the tenants "in common," holding it in alternate fields and stripes without any divisional farms, a system which naturally led to continual discord and discontent, and precluded any possibility of general agricultural improvement. Their first act was to appoint my father, who had become known to them by his statistical survey and chart of the county, their general agent, and he immediately commenced the difficult and unpopular work of reforming the system of tenement, by consolidating the divisional patches respectively into one holding, forming them as nearly as possible into squares, and making straight mearing fences between them, care being always taken to dispose the mearings in such directions that they should, at the same time, serve to water-drain the lands. Within the two first years after this enterprise was undertaken, no less than 27 miles of new roads were made on the estate at the Company's expense, and they were all planted with thorn quicks at their cost, so that each tenant could pass to his own holding without trespassing on those of his neighbours; these roads have since been kept up at their expense. In the old system of plantation, and generally indeed in Ireland, the houses of the occupiers of the soil were crowded into little villages, this was originally done for mutual defence and convenience, and whilst only very small portions of land in the immediate vicinity of the houses were cultivated, was attended with no great degree of injury or objection; but, as the cultivation extended, the evil of this system of rundale and holding in common proportionably increased; with the reformation therefore of this system, it became necessary to induce the occupiers of the lands to remove their houses from the villages, and locate themselves on their allocated tenements. This was a work necessary to the improvement of the estate, yet one which militated greatly against the partialities and prejudices of the people, it was not therefore insisted upon that any such removal should immediately take place, and they were allowed to hold their former houses on paying the mere ground rent to those within whose division the houses were situated; but every encouragement was held out to them by the Company in grants of money and otherwise, to induce them voluntarily to make this removal, and generally it has been effected all over the estate without injury to the feelings, and greatly to the acknowledged advantage of the tenants. This great work of the reformation of the Irish system of tenement, which, at the time it was undertaken, was ridiculed as chimerical and impossible, has happily now been accomplished, and has become the object of imitation by the other great proprietors of this and the adjoining counties.

As to the other territorial improvements, the Company have divided the greater part of the lands which they found waste and mountain into large farms, and have expended much money in fencing and draining them, and in erecting upon them suitable slated dwelling-houses. They have planted in the mountains and glens above 100 acres, and intend to do much more at the expiration of their present leases. The wood at Walworth consists of 260 acres, besides which they have planted themselves quicks (many millions), and trees have been given to the tenants gratis.

Of buildings, they have erected at the cost of £7000, two large and handsome houses of worship for their Presbyterian tenants, one chapel for their Roman Catholic tenants, one grain-market, two large dispensaries, with residences for the medical officers, seven excellent school-houses, new farm-houses, several houses in the village of Ballykelly, a handsome house for their agent, and have also assisted the tenants in building houses, barns, &c. It would be difficult to ascertain the cost of these buildings, but I know a large sum of money was laid out in this way.

The Company paid *annually* before the introduction of the poor laws—

In pensions and occasional charities,	£600
Schools and stationery,	500
Dispensaries and medicines,	270
Grants to Presbyterian and Roman Catholic ministers,	100
Farming societies,	40
Templemoyle school,	40
County infirmary,	10
Total, besides casual donations,	£1560

The examples here cited of systematic efforts to promote the progress of an improvement so vitally important to agriculture, and so beneficial to the health of the population, are deserving of general imitation; and if combined with zeal and perseverance on the part of the small farmers, would, at no distant period, be followed by most important results.

In the County of Derry there are (see table, p. 693) 10,449 farms under 10 acres of land, 6,634 between 10 and 20 acres, 3,013 between 20 and 35 acres, 1,132 between 35 and 50 acres, and 1,242 above 50 acres. If, therefore, on the principle which has been previously enforced, the farmers, proportionably to the extent of their farms, undertook, aided and encouraged by their landlords, the gradual drainage of their land, the following results might be expected:—

10,449	farms under	10, at one-quarter	statute acre,	2,612
6,634	between	10–20, at one-half	...	3,317
3,013	...	20–35, at three-quarters	...	2,260
1,132	...	35–50, at one acre	...	1,132
1,242	above	50, at two acres	...	2,484
			Or annually a total of	11,805

There is, however, one difficulty in the way of draining by small farmers, which is the uncertainty of possessing a final outlet for the water. In mountain districts, where there are necessarily many small streams, or natural drainage courses, this difficulty is less felt, but in more level tracts it must frequently interfere to restrain the formation of drains, the small farmer having no power to make a leading drain, by which the smaller should be discharged. This is an evil consequent on the division of land into small holdings, and is not felt, therefore, in districts or countries such as Scotland or the southern portions of Ireland, where large farms are common; hence it is natural that it should have escaped attention. The Drainage Bill passed during the last Session, provides for large undertakings only, and was, probably, not intended to meet this particular case, though Clause 57 might, perhaps, be so understood as to embrace it—

"And be it enacted, that if it shall be necessary for improving the outfall of any land, or for the purpose of carrying off water from any land to be drained, or from any drain to be made, scoured out, or enlarged under the authority of this Act; to scour out, widen, or enlarge any river or drain, or to make any drain, culvert, or tunnel through any land not included in such district as aforesaid, it shall be lawful for the said Commissioners to enter upon said land, and to scour out, widen, straighten, or enlarge such river or drain, or to make such drain, culvert, or tunnel, due compensation being made by the said Commissioners for any damage done thereby, to be ascertained in such manner as any other compensation is hereafter directed to be ascertained.

To carry such an operation generally into effect, it would seem desirable that the lines of great drains should be determined on the same principles as those of great roads; and though there is some danger in interfering too much with private interests, it may be hoped that every small farmer will hereafter be possessed of a proper outlet for his small drains, in a larger one, laid out and constructed on a principle of general rather than of individual advantage; and to such works as these, it cannot be doubted that public aid would be afforded.

As the object of the climate tables was purely practical, it will not be here attempted to reason upon them in a more general way; nor is the number of years sufficient to form the basis of such reasoning. Still, however, the remarkable condition as to temperature of the month of March, or rather of the first quarter of 1837, deserves to be pointed out, more especially as it is confirmed by the meteorological registers of the three towns—

	Belfast. Mean, 9 A.M.	Dublin. Mean, 9 A.M.	London. Mean, 9 A.M.
January	39·74	39·66	38·4
February	41·96	45·02	40·9
March	41·10	39·51	37·4
	March+January 1·36	—January 0·15	—January 1·0
	—February 0·86	—February 5·51	—February 3·5

The mean temperature, therefore, of March was in the year 1837 the minimum of the year, according to the registers of Dublin and London, and only 1·36 above that of January by the register of Belfast.

1. Popular Impressions of the Weather, contributed by G. Wilkinson, Esq., Architect to the Poor Law Commission; deduced from the Observations of the Clerks of Works employed under his direction.

1841.

F. fine days. P. partly wet partly fine. W. wet.

Name of Union.	1st January to 31st March.			1st April to 30th June.			1st July to 30th September.			1st October to 31st December.			Total.			Days not noticed.
	F.	P.	W.	F.	P.	W.	F.	P.	W.	F.	P.	W.	F.	P.	W.	
ULSTER.																
Ballymoney	39	46	5	41	49	1	33	51	8	31	54	7	144	200	21	.
Dungannon	55	26	9	53	33	5	54	29	9	54	22	15	216	110	38	1
Lisnaskea .	46	39	5	52	30	9	30	54	8	36	47	9	164	170	31	.
Magherafelt	53	28	9	57	33	1	69	18	4	52	39	1	231	118	15	1
Newtonards	51	25	14	59	20	12	63	24	5	50	24	18	223	93	49	.
CONNAUGHT.																
Ballinasloe	51	30	9	50	40	1	46	40	6	44	38	10	191	148	26	.
Mohill . .	53	29	6	70	20	1	72	16	4	59	32	1	254	97	12	2
Tuam . .	54	34	2	54	34	2	54	35	3	55	31	6	217	134	13	1
LEINSTER.																
Abbeyleix	46	41	3	44	44	3	38	51	3	41	42	9	169	178	18	.
Kells . .	62	22	6	60	30	1	55	35	2	59	31	2	236	118	11	.
Mullingar .	59	22	9	61	28	2	55	32	5	56	28	8	231	110	24	.
New Ross .	57	24	7	54	37	.	58	29	5	62	28	2	231	118	14	2
Oldcastle .	48	33	9	59	29	3	41	48	3	56	28	8	204	138	23	.
MUNSTER.																
Ennistymon	51	36	3	55	35	1	41	43	7	38	51	3	185	165	14	1
Lismore .	42	41	7	54	34	3	51	37	4	45	43	4	192	155	18	.
Nenagh . .	57	29	4	62	27	1	50	40	2	53	34	5	222	130	12	1
Average .	51	32	7	55	33	3	51	36	5	49	36	7	207	136	21	.

2. Similar Table for the Provinces, incorporating all the Partial Observations of separate quarters.

F. fine days. P. partly wet partly fine. W. wet.

	1st January to 31st March.			1st April to 30th June.			1st July to 30th September.			1st October to 31st December.			Total.			Days not noticed.
	F.	P.	W.	F.	P.	W.	F.	P.	W.	F.	P.	W.	F.	P.	W.	
ULSTER .	47	34	9	50	36	5	46	39	7	41	44	7	184	153	28	.
CONNAUGHT	52	29	8	53	34	3	48	35	9	45	40	7	198	138	27	.
LEINSTER	52	29	8	58	30	3	48	40	4	52	34	6	210	133	21	.
MUNSTER .	45	37	7	56	32	3	41	46	5	41	44	7	183	159	22	.
IRELAND	49	33	8	54	33	4	46	40	6	44	41	7	193	147	25	.

3. Classification of the Weather in reference to the actual Quantities of Rain by years.

DUBLIN.

Years.		Equivalent to Fair.		Light Showers.		Rainy.			Heavy Rain.		Summary.				
	Days no Rain.	·01 inch and under.	·01 to ·02 inch.	·02 to ·03 inch.	·03 to ·05 inch.	·05 to ·1 inch.	·1 to ·2 inch.	·2 to ·3 inch.	·3 to ·5 inch.	Above ·5 inch.	Days no Rain.	Fair.	Light Showers.	Rainy.	Heavy rain.
1836	133	28	29	23	31	48	41	12	11	10	133	57	54	101	21
1837	177	18	17	15	24	29	34	26	15	10	177	35	39	89	25
1838	156	26	24	18	20	43	31	22	13	12	156	50	38	96	25
1839	149	41	22	11	23	37	34	16	13	19	149	63	34	87	32
1840	165	36	17	16	31	32	33	9	17	9	165	53	47	74	26
1841	120	48	29	15	20	39	57	19	8	10	120	77	35	115	18
Average	150	33	23	16	25	38	38	17	13	12	150	56	41	94	24

LONDON.

Years.		Equivalent to Fair.		Light Showers.		Rainy.			Heavy Rain.		Summary.				
	Days no Rain.	·01 inch and under.	·01 to ·02 inch.	·02 to ·03 inch.	·03 to ·05 inch.	·05 to ·1 inch.	·1 to ·2 inch.	·2 to ·3 inch.	·3 to ·5 inch.	Above ·5 inch.	Days no Rain.	Fair.	Light Showers.	Rainy.	Heavy Rain.
1836	209	.	3	6	32	35	47	17	14	3	209	3	38	99	17
1837	242	1	4	5	24	31	33	9	10	6	242	5	29	73	16
1838	228	2	12	8	29	25	28	12	15	6	228	14	37	65	21
1839	211	1	8	9	29	27	35	22	17	6	211	9	38	84	23
1840	241	.	10	7	15	29	30	15	19	.	241	10	22	74	19
1841	188	4	13	15	19	45	37	14	20	10	188	17	34	96	30
Average	220	1	8	8	25	32	35	15	16	5	220	10	33	82	21

4. Annual Quantities of Rain in inches.

Locality.	1836.	1837.	1838.	1839.	1840.	1841.
Belfast .	37·033	31·273	37·384	37·786	31·559	34·762
Dublin .	27·049	28·134	30·565	34·826	25·788	28·882
London .	22·748	17·942	19·537	24·504	18·184	27·372

5. Monthly Averages of Temperature, Maxima and Minima, and Quantity of Rain; deduced from the Register kept at the Linen Hall Library.

BELFAST.

1836. 1837.

Months.	Mean Temp.		Maximum.	Minimum.	Rain inches.	Months.	Mean Temp.		Maximum.	Minimum.	Rain inches.
	9 A.M.	3 P.M.					9 A.M.	3 P.M.			
January .	41·13	47·34	51·75	28·50	4·579	January .	39·74	41·60	51·25	28·00	3·144
February .	40·27	44·55	52·25	28·00	1·335	February	41·96	45·98	57·75	30·00	3·313
March . .	43·32	47·79	60·25	29·50	3·150	March . .	41·10	44·30	57·75	24·75	0·558
April . .	48·94	52·16	61·75	30·50	2·002	April . .	45·55	49·17	63·00	32·00	2·067
May . .	54·71	64·48	72·50	35·50	0·259	May . .	54·75	59·43	68·00	40·00	1·595
June . .	62·59	66·51	76·75	45·50	3·195	June . .	63·35	64·54	84·00	49·00	1·773
July . .	61·80	65·31	81·25	46·00	5·245	July . .	65·12	69·10	77·00	50·00	4·355
August .	61·00	64·93	74·00	34·00	2·060	August .	61·92	67·14	78·75	49·25	1·819
September	55·18	58·45	66·00	36·09	4·011	September	56·45	60·43	70·75	44·00	2·488
October .	48·93	52·93	62·00	26·25	4·758	October .	52·04	55·45	66·25	29·75	2·450
November	41·58	45·42	58·25	29·00	4·863	November	44·08	46·23	58·75	29·00	3·140
December	40·65	42·75	54·50	27·75	1·571	December	44·47	46·45	55·25	30·00	4·570
For the year	50·01	54·38	81·25	26·25	37·028	For the year	50·88	54·15	84·00	24·75	31·272

1838. 1839.

January .	35·99	38·13	50·75	19·25	1·824	January .	37·00	40·25	53·25	18·75	2·630
February .	35·09	39·25	49·25	11·75	2·503	February	39·15	43·84	56·00	42·75	2·427
March . .	43·50	47·16	60·00	30·00	4·741	March . .	42·08	45·78	57·50	35·00	3·032
April . .	47·49	48·27	63·25	26·75	3·127	April . .	48·15	52·36	72·00	32·00	1·453
May . .	53·70	59·64	70·00	36·00	1·756	May . .	54·45	59·06	70·25	36·50	0·949
June . .	60·45	65·86	75·75	50·00	3·122	June . .	61·53	65·67	78·25	43·75	3·581
July . .	62·47	66·87	77·25	50·00	3·772	July . .	63·08	66·45	76·50	51·50	3·983
August .	61·37	64·91	78·75	47·00	3·279	August .	60·19	64·38	73·50	44·75	2·802
September	57·52	62·10	73·25	43·00	2·471	September	55·42	59·85	70·25	41·00	5·478
October .	50·65	54·47	64·00	30·00	1·941	October .	50·00	53·62	61·00	32·75	3·825
November	43·39	45·36	56·25	32·00	5·740	November	45·89	48·67	57·00	27·50	4·051
December	42·31	44·73	53·75	27·00	3·108	December	40·52	43·05	52·50	26·00	3·575
For the year	49·49	53·06	78·75	11·75	37·384	For the year	49·79	53·58	78·25	18·75	37·786

1840. 1841.

January .	41·70	43·70	54·00	.	4·273	January .	34·75	38·93	51·50	18·50	2·484
February .	40·82	42·73	55·00	.	2·684	February .	40·27	43·07	53·75	27·50	1·777
March .	44·99	48·87	58·50	.	0·412	March . .	47·62	51·44	62·25	29·50	3·943
April . .	53·14	57·82	74·50	38·00	0·911	April . .	50·10	55·00	65·00	34·00	2·389
May . .	55·61	60·05	78·00	40·00	2·244	May . .	59·81	63·93	75·75	40·50	2·140
June . .	60·44	64·30	78·50	46·00	2·417	June . .	60·97	65·11	76·75	48·00	3·358
July . .	60·94	63·69	77·00	45·50	3·318	July . .	60·80	65·14	77·50	47·75	2·821
August .	64·03	69·13	79·75	49·00	3·534	August .	62·07	65·13	76·00	47·00	3·387
September	53·99	57·25	.	.	3·403	September	60·17	63·43	74·00	45·00	2·536
October .	48·60	53·04	.	.	1·477	October .	49·16	51·66	62·50	25·00	4·381
November	43·26	46·38	.	.	4·261	November	42·16	45·39	58·00	23·75	2·590
December	39·01	41·90	.	.	2·624	December	42·21	43·37	53·50	24·25	2·949
For the year	50·54	54·07	.	.	31·559	For the year	50·84	54·30	77·50	18·50	34·755

6. Monthly Averages of Temperature, Maxima and Minima, and Quantity of Rain, deduced from the Register of the College of Surgeons, contributed by Dr. Apjohn.

DUBLIN.

1836.

Months.	Mean of daily Maxima and Minima.	Maximum.	Minimum.	Day of Month. Max.	Day of Month. Min.	Rain inches.
January	41·66	53·0	27·0	23	12 & 30	1·925
February	40·53	53·5	26·0	16	27	1·735
March .	43·65	61·0	31·5	19	8	3·025
April .	46·86	60·0	32·0	15	2	0·933
May . .	54·42	71·5	34·5	16	1	0·440
June .	60·17	73·5	45·0	16	7	1·407
July . .	60·74	83·0	46·5	6	31	4·432
August	59·73	74·0	44·5	13	25	1·957
Septem.	53·73	66·5	39·5	24 & 26	11	3·428
October	48·79	65·5	27·5	18	31	2·685
Novem.	42·92	56·0	29·0	28	8	2·955
Decem.	42·18	58·0	27·0	18	25, 26 & 31	2·127
For the year	49·61	83·0	26·0	July 6	Feb. 27	27·049

1837.

Months.	Mean of daily Maxima and Minima.	Maximum.	Minimum.	Day of Month. Max.	Day of Month. Min.	Rain inches.
January	39·66	58·5	27·0	23	11	2·020
February	45·02	60·5	34·0	17	24	3·013
March .	39·51	52·0	26·5	10	14 & 24	0·987
April .	43·61	60·0	29·0	20 & 26	17	2·575
May . .	52·50	72·0	34·5	17	10	2·305
June .	60·77	77·0	45·0	30	4	2·112
July . .	64·48	76·5	47·0	21 & 23	2	4·151
August	61·42	75·0	42·0	18 & 19	30	2·069
Septem.	57·38	69·5	41·5	8	15	2·586
October	53·41	69·0	35·0	2	29	1·318
Novem.	44·87	57·0	31·0	11	25	1·918
Decem.	45·48	56·0	27·0	25	5	3·080
For the year	50·68	77·0	26·5	June 30	Mar14 & 24	28·134

1838.

January	37·02	50·5	23·0	6	12	2·495
February	37·23	50·0	24·5	9	11	5·356
March .	42·19	57·0	27·0	14	24	1·843
April .	46·28	[illegible]	27·5	11	2	2·399
May . .	[illegible]	[illegible]	[illegible]	9 & 10	2	1·851
June .	[illegible]	[illegible]	43·5	18	8	1·365
July . .	[illegible]	78·0	49·0	10	23 & 25	2·024
August .	61·29	76·0	47·0	28	30	3·568
Septem.	57·56	70·0	39·0	1 & 13	27	1·095
October	50·95	64·0	31·5	1	13	1·988
Novem.	43·02	56·0	29·5	7 & 8	13	4·933
Decem.	43·08	57·5	28·0	9	9	1·648
For the year	49·28	78·0	23·0	July10	Jan. 12	30·565

1839.

January	38·86	54·5	24·0	12	18	2·524
February	41·36	55·5	26·0	9	1	1·441
March .	43·74	57·0	26·0	24 & 28	8	2·552
April .	48·53	67·0	33·0	28	5 & 6	1·801
May . .	54·35	74·0	31·5	1 & 29	15	0·735
June . .	61·26	77·0	45·0	21	30	2·333
July . .	62·29	80·5	49·5	6	30	5·983
August .	60·27	76·0	43·0	5	21	2·923
Septem.	57·28	76·0	42·0	6	13	4·473
October	50·94	64·5	36·5	2	18	3·696
Novem.	45·87	56·0	28·5	17	27 & 28	3·926
Decem.	40·59	52·0	27·5	1 & 26	29	2·439
For the year	50·44	80·5	24·0	July 6	Jan. 18	34·826

1840.

January	42·17	54·0	29·0	16 & 24	9 & 30	3·254
February	40·15	56·0	26·0	17	28	1·451
March .	43·19	54·5	28·0	21	1	0·313
April .	52·82	78·5	34·0	29	7 & 8	0·698
May . .	55·63	75·2	41·5	2	18 & 19	3·277
June . .	60·56	80·0	46·0	1	3 & 24	1·620
July . .	59·66	77·0	46·0	31	13	1·983
August	64·43	85·0	49·0	10	17 & 31	3·218
Septem.	54·93	74·5	34·5	2	12	2·013
October	47·81	60·0	33·5	12 & 13	30	2·083
Novem.	43·38	56·0	30·5	30	28	4·014
Decem.	39·32	55·0	29·0	1	29	1·864
For the year	50·34	85·0	26·0	Aug. 10	Feb. 28.	25·788

1841.

January	36·16	50·5	19·0	27	7	2·428
February	40·01	53·0	27·5	22 & 23	7	1·115
March	47·13	59·0	31·0	25	4	2·375
April .	50·17	70·0	35·5	30	22	1·078
May . .	57·06	77·0	35·5	28	3	1·806
June . .	60·00	77·0	45·0	11	4	1·677
July . .	59·56	71·5	47·0	18	9	2·347
August	61·30	78·0	46·0	29	24	2·686
Septem.	58·22	73·5	41·5	14	4	1·961
October	48·58	61·0	34·5	2	21	4·903
Novem.	42·09	56·0	27·5	7	17	3·391
Decem.	41·48	56·0	25·0	9	20	3·115
For the year	50·15	78·0	19·0	Aug. 29	Jan. 7	28·882

7. Monthly Averages of Temperature and Quantities of Rain, deduced from the Register of the Royal Society, as published in the Athenæum.

LONDON.

1836.

Months.	Mean of daily Temp.		Maximum.	Minimum.	Day of Month.		Rain inches.
	9 A.M.	3 P.M.			Max.	Min.	
January	38·6	41·7	53·4	17·5	23	2	1·599
February	38·0	42·7	50·6	25·3	9	21	2·056
March	45·2	49·5	64·4	31·8	20	27	2·430
April	46·1	50·1	61·3	32·2	22	30	2·488
May	53·1	60·0	69·5	35·3	16	1	0·808
June	63·0	67·2	82·6	47·7	28	6	0·898
July	68·2	70·8	85·2	46·2	4	21	1·886
August	61·5	67·9	73·4	48·4	17	25	0·993
September	56·0	59·6	68·5	40·7	1	22	2·773
October	49·3	52·6	61·2	30·0	18	31	3·063
November	43·1	46·3	56·7	31·3	28	8	2·103
December	41·0	43·4	55·6	28·2	5	31	1·646
For the year	50·3	54·3	85·2	17·5	July 4	Jan. 2	22·748

1837.

Months.	Mean of daily Temp.		Maximum.	Minimum.	Day of Month.		Rain inches.
	9 A.M.	3 P.M.			Max.	Min.	
January	38·4	40·6	50·7	24·0	24	2	2·313
February	40·9	45·0	54·0	30·0	17	7	1·580
March	37·4	41·3	49·2	26·7	10	21	0·433
April	42·4	45·3	59·2	28·0	27	12	0·900
May	50·6	55·6	66·3	35·5	31	10	1·674
June	61·4	67·0	75·8	43·2	16	8	0·890
July	63·8	69·2	79·6	47·5	28	2	1·434
August	62·7	68·3	78·8	43·5	18	27	3·602
September	57·6	61·6	69·7	44·1	18	27, 28, 29	0·895
October	51·5	57·2	63·5	35·4	5	26	1·821
November	41·2	46·4	56·4	28·0	2	9	1·419
December	42·2	44·8	55·3	31·7	26	7	0·981
For the year	49·2	53·6	79·6	24·0	July 28	Jan. 2.	17·942

1838.

January	30·1	32·4	50·2	11·4	1	16	0·072
February	33·8	37·4	48·7	24·8	26	13	1·677
March	42·7	47·6	58·3	31·0	15	23	0·929
April	44·7	49·0	64·2	29·8	12	2	0·664
May	53·4	59·3	73·3	36·2	9	15	0·571
June	60·5	64·2	79·7	44·2	24	8	4·372
July	63·3	68·1	79·0	49·6	17	25	2·259
August	62·8	67·4	76·0	46·5	28, 29	30	1·050
September	55·9	61·5	69·6	42·8	1	22	2·247
October	51·5	55·1	61·2	32·8	4, 22	14	1·360
November	41·9	45·3	57·7	30·0	8	27	2·735
December	39·6	42·4	55·0	29·8	3	26	1·601
For the year	48·4	52·5	79 7	11·4	June 24	Jan. 16	19·537

1839.

January	38·2	40·9	51·8	23·7	14	30	1·428
February	40·5	44·4	52·3	26·8	15	1	1·337
March	41·3	45·0	53·3	26·0	8	9	1·549
April	44·8	49·2	58·7	30·5	30	7	1·377
May	52·3	58·9	72·2	33·7	27	16	1·275
June	61·9	66·3	85·0	45·6	9, 20	2	1·520
July	63·1	67·3	80·3	48·6	6	1	2·577
August	62·1	66·5	78·6	45·4	4	21	1·968
September	58·3	61·7	70·0	45·0	11	30	2·982
October	50·5	54·6	63·5	37·3	12	29	1·958
November	46·4	49·1	55·3	33·4	18	28	4·207
December	41·0	43·9	54·6	32·0	24	4, 30, 31	2·326
For the year	50·0	54·0	85·0	23·7	June 9, 20	Jan. 30	24·504

1840.

January	40·4	43·5	54·2	22·3	20	8, 9	2·633
February	39·3	42·5	51·0	27·8	8	24	1·224
March	39·7	44·7	53·7	30·7	11	1	0·215
April	50·9	59·5	72·2	34·4	30	4	0·254
May	56·3	62·1	.	41·3	.	20	2·329
June	62·6	66·8	83·0	48·3	1	4	1·760
July	61·5	65·5	77·2	49·4	15	18	1·815
August	64·3	70·8	80·0	52·4	4	9	1·272
September	57·3	60·0	76·2	41·7	2	12	1·854
October	47·2	52·7	60·7	35·4	15	26	1·473
November	44·1	47·6	60·6	30·3	17	29, 30	2·942
December	34·4	36·6	55·5	21·2	2	18	0·413
For the year	49·8	54·4	83·0	21·2	June 1	Dec. 18	18·184

1841.

January	35·3	38·0	52·8	14·9	28	9	2·224
February	36·4	38·9	52·2	21·6	21	8	0·790
March	47·1	53·6	64·2	35·0	27	2	1·047
April	48·4	53·6	72·4	36·7	28	12	1·748
May	59·6	64·4	79·4	45·3	27	4	1·987
June	58·9	62·8	87·0	45·3	20	7	2·308
July	60·7	64·3	80·3	49·8	7	13	2·524
August	62·5	67·7	77·5	50·0	21	1	2·168
September	60·1	64·4	78·5	42·8	13	6	3·715
October	50·5	54·1	64·3	37·2	1	26	4·142
November	43·9	47·5	58·6	28·2	30	17	2·850
December	41·5	43·8	55·8	29·9	1	19	1·869
For the year	50·4	54·4	87·0	14·9	June 20	Jan. 9	27·372

8. Classification of the Weather by Months.

DUBLIN.

1836.

Months.	Days no rain.	Fair.	Lightshowers.	Rainy.	Heavy rain.
January	4	6	8	13	.
February	6	11	7	4	1
March	5	4	6	15	1
April	7	10	7	6	.
May	28	1	1	.	1
June	9	5	5	11	.
July	13	2	2	8	6
August	20	2	2	5	2
September	14	2	1	10	3
October	15	4	2	7	3
November	6	5	8	8	3
December	6	5	5	14	1
Total,	133	57	54	101	21

1837.

Months.	Days no rain.	Fair.	Lightshowers.	Rainy.	Heavy rain.
January	12	4	4	11	.
February	11	4	1	9	3
March	12	8	7	8	1
April	15	3	1	8	3
May	14	3	3	9	2
June	16	1	3	9	1
July	16	1	2	7	5
August	23	.	2	4	2
September	17	2	3	4	4
October	21	2	2	5	1
November	8	5	7	10	.
December	12	2	4	10	3
Total,	177	35	39	89	25

1838.

Months.	Days no rain.	Fair.	Lightshowers.	Rainy.	Heavy rain.
January	13	3	2	11	2
February	9	3	3	7	6
March	11	6	3	10	1
April	13	1	5	10	1
May	16	5	3	5	2
June	10	6	4	10	.
July	15	5	1	8	2
August	10	3	.	15	3
September	20	3	3	3	1
October	16	3	5	5	2
November	9	4	7	5	5
December	14	8	2	7	.
Total,	156	50	38	96	25

1839.

January	10	10	4	6	1
February	10	6	4	7	1
March	8	7	4	11	1
April	19	3	1	6	1
May	24	3	1	2	1
June	15	3	4	6	2
July	11	3	2	8	7
August	8	6	2	12	3
September	10	4	3	9	4
October	10	8	4	4	5
November	10	4	2	11	3
December	14	6	3	5	3
Total,	149	63	34	87	32

1840.

January	9	4	3	12	3
February	12	2	7	7	1
March	26	2	1	2	.
April	22	.	7	.	1
May	13	6	1	4	6
June	9	8	6	6	1
July	6	5	7	13	.
August	15	3	2	7	4
September	13	3	6	6	2
October	17	4	1	8	1
November	7	9	3	5	6
December	16	7	3	4	1
Total,	165	53	47	74	26

1841.

January	10	5	7	8	1
February	9	6	4	9	.
March	9	7	3	11	1
April	12	7	5	6	.
May	15	7	2	6	1
June	14	6	2	6	2
July	6	7	3	15	.
August	11	4	2	11	3
September	11	8	1	9	1
October	8	5	1	13	4
November	8	6	1	12	3
December	7	9	4	9	2
Total,	120	77	35	115	18

LONDON.

1836.

January	22	.	4	3	2
February	19	.	3	5	2
March	12	.	5	13	1
April	11	1	6	9	3
May	25	.	1	4	1
June	18	1	4	7	.
July	22	.	1	6	2
August	22	1	2	6	.
September	13	.	4	11	2
October	15	.	2	12	2
November	11	.	4	15	.
December	19	.	2	8	2
Total,	209	3	38	99	17

1837.

January	17	.	2	9	3
February	17	.	3	7	1
March	25	.	2	4	.
April	23	.	.	7	.
May	22	.	2	6	1
June	20	.	3	7	.
July	21	.	3	6	1
August	17	1	5	2	6
September	20	1	.	9	.
October	20	.	4	4	3
November	19	2	3	5	1
December	21	1	2	7	.
Total,	242	5	29	73	16

1838.

January	30	.	.	1	.
February	19	.	2	5	2
March	22	.	1	8	.
April	19	2	5	4	.
May	22	1	4	4	.
June	10	2	4	8	6
July	13	2	4	10	2
August	17	4	2	7	1
September	20	.	6	1	3
October	23	1	1	4	2
November	13	1	4	9	3
December	20	1	4	4	2
Total,	228	14	37	65	21

1839.

January	20	.	5	5	1
February	15	.	4	8	1
March	19	1	4	6	1
April	20	.	2	7	1
May	22	1	3	3	2
June	18	.	3	8	1
July	19	.	3	6	3
August	21	1	1	6	2
September	9	5	4	9	3
October	18	1	3	8	1
November	12	.	5	9	4
December	18	.	1	9	3
Total,	211	9	38	84	23

1840.

January	15	1	5	7	3
February	16	3	1	8	1
March	27	.	3	1	.
April	26	.	2	2	.
May	19	1	1	7	3
June	19	.	2	7	2
July	17	3	2	7	2
August	20	1	1	8	1
September	18	1	1	9	1
October	21	.	2	6	2
November	14	.	2	11	3
December	29	.	.	1	1
Total,	241	10	22	74	19

1841.

January	17	1	3	8	2
February	18	.	3	7	.
March	19	.	5	7	.
April	15	.	4	9	2
May	19	2	2	6	2
June	21	1	2	2	4
July	13	2	6	8	2
August	13	7	1	7	3
September	16	1	.	6	7
October	9	2	3	12	5
November	17	.	.	10	3
December	11	1	5	14	.
Total,	188	17	34	96	30

Classification of the Weather by Months—(*continued*).

AVERAGE FOR DUBLIN.						AVERAGE FOR LONDON.					
Months.	Days no rain.	Fair.	Light showers.	Rainy.	Heavy rain.	Months.	Days no rain.	Fair.	Light showers.	Rainy.	Heavy rain.
January . . .	10	5	5	10	1	January . . .	20	.	3	6	2
February . . .	10	5	4	7	2	February . . .	17	.	3	7	1
March . . .	12	6	4	8	1	March . . .	21	.	3	7	.
April	15	4	4	6	1	April	19	1	3	6	1
May	18	4	2	5	2	May	21	1	2	5	2
June	12	5	4	8	1	June	18	1	3	6	2
July	11	4	3	10	3	July	18	1	3	7	2
August . . .	14	3	2	9	3	August . . .	18	3	2	6	2
September . . .	14	4	3	7	2	September . . .	16	1	3	7	3
October . . .	14	4	3	7	3	October . . .	18	1	2	8	2
November . . .	8	5	5	9	3	November . . .	14	1	3	10	2
December . . .	11	[illegible]	4	8	2	December . . .	20	1	2	7	1
Total, . .	149	55	43	94	24	Total, . .	220	11	32	82	20

9. Cost of Drainage per Irish acre, with loose stones, subdivided according to the Scotch system.

Subsoils to which the distances are applicable.	Distance between the drains in feet.	Roods per acre.	Cost per rood to landlord.		Cost per acre to landlord.			Cost per rood to farmer.		Cost per acre to farmer.			Total cost per acre.		
			s.	*d.*	£	*s.*	*d.*	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
For hard till subsoil .	10	61	3	4	10	3	4	1	8	5	1	8	15	5	0
	11	55½	—		9	5	4	—		4	12	8	13	18	0
	12	50⅚	—		8	9	5¼	—		4	4	8¾	12	14	2
Stiff clay .	13	47	—		7	16	8¾	—		3	18	4½	11	15	1¼
	14	43⅗	—		7	5	4¾	—		32	1	9	10	18	1¾
Sandy clay .	15	40⅔	—		6	15	6¾	—		3	7	9¼	10	3	4
	16	38⅛	—		6	7	1	—		3	3	6½	9	10	7½
	17	36	—		5	19	8	—		2	19	10	8	19	6
	18	34	—		5	13	3¾	—		2	16	8	8	9	11¾
	19	32⅕	—		5	7	3¼	—		2	13	8¼	8	0	11¾
	20	30½	—		5	1	8	—		2	10	10	7	12	6
Free stony bottom .	21	29¼	—		4	17	5¼	—		2	8	8½	7	6	1¾
	22	27⅗	—		4	12	1½	—		2	6	1	6	18	2½
	23	26⅓	—		4	7	10¾	—		2	3	11¼	6	11	10¼
	24	$25\frac{5}{12}$	—		4	4	8¾	—		2	2	4¼	6	7	1
	25	24½	—		4	1	6½	—		2	0	9¼	6	2	3¾
	26	23½	—		3	18	4½	—		1	19	2¼	5	17	6½
	27	22½	—		3	15	2¼	—		1	17	7	5	12	9¼
	28	21⅗	—		3	12	0¼	—		1	16	0½	5	8	0¼
	29	21	—		3	9	10¾	—		1	14	11¼	5	4	10¼
More open bottom .	30	20⅓	—		3	7	9¼	—		1	13	10¾	5	1	8
	31	$19\frac{7}{10}$	—		3	5	8	—		1	12	10	4	18	6
	32	19	—		3	3	6½	—		1	11	9¼	4	15	3¾
	33	18⅖	—		3	1	5	—		1	10	8½	4	12	1½
Irregular beds of gravel or sand, and irregularly open stratification .	34	17¾	—		2	19	3¾	—		1	9	7¾	4	8	11½
	35	17½	—		2	18	3	—		1	9	1½	4	7	4½
	36	17	—		2	16	5¼	—		1	8	3¼	4	4	8½
	37	16½	—		2	15	0¾	—		1	7	6½	4	2	7¼
	38	16⅕	—		2	14	0¼	—		1	7	0	4	1	0¼
	39	15⅔	—		2	12	2½	—		1	6	2	3	18	4½
	40	15¼	—		2	10	10	—		1	5	5	3	16	3

10. Cost of drainage where Tiles are used, per Irish acre.

Distance between the drains in feet.	Roods per acre.	Cost of Tiles with soles, and reckoning 100 to the rood of drains.												Cost of cutting and laying.					
		Tiles, 14*s.* Soles, 7*s.* 2*s.* 1*d.* per rood.			Tiles, 18*s.* Soles, 9*s.* 2*s.* 8*d.* per rood.			Tiles, 22*s.* Soles, 11*s.* 3*s.* 4*d.* per rood.			Tiles, 28*s.* Soles, 14*s.* 4*s.* 2*d.* per rood.			In Carse, 1*s.* per rood.			In Dryfield. 2*s.* per rood.		
		£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
10	61	6	7	1	8	2	8	10	3	4	12	14	2	3	1	0	6	2	0
11	55½	5	15	10¼	7	8	3¼	9	5	4	11	11	8½	2	15	7¼	5	11	2¼
12	50⅚	5	5	10¾	6	15	6¾	8	9	5¼	10	11	9¾	2	10	10	5	1	8
13	47	4	17	11½	6	5	4¾	7	16	8¾	9	15	11	2	7	0¼	4	14	0½
14	43⅗	4	10	10¼	5	16	3¼	7	5	4¾	9	1	10	2	3	7½	4	7	3¼
15	40⅔	4	14	8¾	5	8	5¼	6	15	6¾	8	9	5¼	2	0	8	4	1	4
16	38⅛	3	9	5	5	1	8	6	7	1	7	18	10¼	1	18	1½	3	16	3
17	36	3	14	9¼	4	15	8¾	5	19	8	7	9	7¾	1	15	10¾	3	11	9½
18	34	3	10	10¼	4	10	7¾	5	13	3¾	7	1	8¼	1	14	0	3	7	11¾
19	32⅕	3	7	0½	4	5	9¼	5	7	3¼	6	14	2¼	1	12	2¼	3	4	4¾
20	30½	3	3	6½	4	1	4	5	1	8	6	7	1	1	10	6	3	1	0
21	29¼	3	0	10¾	3	17	11¼	4	17	5¼	6	1	9½	1	9	2¾	2	18	5½
22	27⅗	2	17	7¼	3	13	8½	4	12	1½	5	15	2¾	1	7	7¾	2	15	3¼
23	26⅓	2	14	11½	3	10	3¾	4	7	10¾	5	9	11¼	1	6	4½	2	12	8¾
24	25 5/12	2	12	11½	3	7	9¼	4	4	8¾	5	5	10¾	1	5	5	2	10	10
25	24½	2	10	11¼	3	5	2¾	4	1	6½	5	1	10½	1	4	5½	2	8	11¼
26	23½	2	9	0½	3	2	8¼	3	18	4½	4	17	11½	1	3	6¼	2	7	0¼
27	22½	2	7	0¼	3	0	1¾	3	15	2¼	4	14	0½	1	2	6¾	2	5	1¼
28	21⅗	2	5	0	2	17	7¼	3	12	0¼	4	10	0¼	1	1	7¼	2	3	2½
29	21	2	3	9¾	2	15	11	3	9	10¾	4	7	4½	1	0	11½	2	1	11¼
30	20⅓	2	2	4¼	2	14	2¾	3	7	9¼	4	4	8¾	1	0	4	2	0	8
31	19 7/10	2	1	1	2	12	6¼	3	5	8	4	2	1	0	19	8¼	1	19	4¾
32	19	1	19	8½	2	10	10	3	3	6½	3	19	5¼	0	19	0¾	1	18	1½
33	18⅗	1	18	5¼	2	9	1¾	3	1	5	3	16	9¼	0	18	5¼	1	16	10¼
34	17¾	1	17	0¾	2	7	5¼	2	19	3¾	3	14	1½	0	17	9½	1	15	7
35	17½	1	16	5¼	2	6	7¼	2	18	3	3	12	10¼	0	17	5¾	1	14	11¼
37	17	1	15	3¼	2	5	1¼	2	16	5¼	3	10	7¾	0	16	11¼	1	13	10¾
36	16½	1	14	5	2	4	0¾	2	15	1	3	8	10	0	16	6¼	1	13	0½
38	16⅔	1	13	9½	2	3	2½	2	14	0¼	3	7	6¾	0	16	2½	1	12	4¾
39	15⅔	1	12	7½	2	1	8¾	2	12	2½	3	5	4	0	15	8	1	11	4¼
40	15¼	1	11	9¼	2	0	8	2	10	10	3	3	6½	0	15	3	1	10	6

Tables 9 and 10 have been reduced to the Irish measure from the tables of James Smith, Esq., of Deanston. The rood is thirty-six yards. Other tables of a similar nature have been drawn up by various persons, and are cited by Mr. Cuthbert Johnstone in the Farmer's Encyclopædia. In Mr. Carmichael's, which is one of them, the expense of stone drains on alum clay is stated as £5 11*s.* 11*d.* the imperial acre, the drains being 18 feet apart, 20 inches deep, and 5 inches wide at the bottom; the number of yards per acre 806, and the number of cart loads of stones 44½. This would amount to £9 1*s.* 3½*d.* the Irish acre.

No. III.

MINERAL STATISTICS.

THE intimate connection of geology as a science, with all those practical arts which embrace the use of mineral products, is so natural and evident that it is unnecessary to dwell upon it at any great length, more especially as it has been already noticed in the introductory chapter, and so recently illustrated by some of the ablest writers. The roadmaker, the limeburner, the brickmaker, the potter, the miner, and the farmer, are all, in their several occupations, operating upon those mineral substances which it is the business of the geologist to search after and to investigate, the practical art being a sequel to the theoretical science. The useful results which thus necessarily follow the inquiries of the geologist have been classified and arranged in tables, which are thus a practical supplement to the geological map. The tables have only been completed for the County of Derry and barony of Dungannon in Tyrone, but that portion of them which is connected with agriculture will convey a tolerably accurate notion of the average condition of the whole district examined.

The first table notices the use of the rock or stone by the roadmaker or builder, which is one of the most simple applications of a mineral product. In the columns of worked and unworked quarries the great number of the latter is the result of the common practice of opening a hole or quarry, working it for a short time or for a specific purpose, and then abandoning it; the mode of working is indeed in such cases so rude, that the progress of the work is soon stopped by the difficulty of clearing the quarry of water. Such a system must often lead to the use of very inferior stone, but this is not considered a point of much importance by the ordinary farmer. In the barony of Tirkeeran the schists have been quarried as roofing slates, and the offices of the Templemoyle Agricultural Seminary were covered with them. The slates hitherto quarried have been thick and heavy, requiring a strong roof, and though wearing tolerably well, have a tendency to absorb moisture and induce vegetation. The principal quarry for this purpose was that of Gortnacross, but it is also probable, from the apparent prevalence of a transverse cleavage or lamination in the schists at Kildoag, that they would yield, if quarried to a sufficient depth, even better slates than the former did. For tombstones, flagging, and gate posts, some of the harder varieties are well fitted, but for roads they should only be used with great caution, and those selected which have assumed a hornblendic character. The map exhibits the localities of the associated hornblendic rocks, and none other, if possible, should be used for this purpose, even the hard quartzose varieties of the schists being deficient in the requisite tenacity, a quality inherent to hornblendic rocks. As a building stone, many of the schists are only fitted for rough buildings or cabins, but others are of a tolerable quality, and suit very well where dressing is not required; in such cases they must be replaced by limestone or freestone. Generally speaking the freestones are the best for building; their quality is, in some degree, dependent on their geological position, the beds of the old red and new red sandstone being earthy and crumbly, as well as inferior in colour to those of the carboniferous system. The carboniferous grits are the handsomest and most durable of this class of stone, and it is only necessary to follow the indications of the map to know where good building freestones may be found. In Bovevagh and Dungiven, grits of this description have been extensively quarried, as well as in Ballynascreen, and the more fully developed the freestone is, the better its quality usually proves; when mixed up with shales, they are often slaty.

In Tyrone and Fermanagh the same geological position is invariably that of the best quality of stone, and in the parishes of Carnteel, Aghaloo, Clogher, Drumkeeran, there is a rich supply of very excellent stone. The only fault this freestone possesses is, that it sometimes, on exposure, becomes disfigured by ochreous stains, minute particles of oxide of iron being disseminated in the mass. This evil may be often avoided by a judicious selection of the beds, and when perfect and well dressed, it is a handsome stone. As good examples of these freestones, the Bovevagh and Dungiven grits may be cited from the lower section of the system; the grits on the Clogher River, the Carrycastle grits in Aghaloo and Clonfeacle parishes, and the Drumkeeran grits on the Bannagh, from the section above the lower limestone, and some of these are extremely compact, white, and beautiful. The basalts are also used extensively as building stones, and when relieved by limestone or freestone coins, are not disagreeable, though when used alone they have a dark and gloomy appearance. Care must be taken also to avoid those varieties which exhibit a tendency to weather in globular or shot-like lumps, with ochreous onion-like coatings. As a road stone some varieties of this rock are excellent, possessing the requisite tenacity, and not, like quartz rocks or flints, exposing sharp, cutting edges. There can be little doubt that it would be cheaper to quarry and break up this stone, and then cart it for a considerable distance, than to use schists, sandstones, or chalk, though obtained on the spot. The excellence of the roads in basaltic districts, consequent on the original tenacity and regularity of wear of the rock, exemplifies its utility for this purpose. The quarries included in the tables may be summed up in the several baronies thus: Tirkeeran, 52 worked, of which sixteen limestone and five building stone are restricted to the tenants. The Altaghoney limestone is used for tombstones; the price, when polished, being £4, 10*s*. for a stone 7 feet by 3·5 feet by 5 inches.—Keenaght, 31 worked, of which seven are limestone quarries restricted to the tenants.—Loughinsholin, 56 worked, of which four are restricted to the tenants, and two are worked for sharpening stones, one hundred and sixty-five gross of which are raised per annum.—North-east Liberties of Coleraine, 40 worked.—Coleraine, 13 worked, of which one is free to the tenantry.—Dungannon, 190 worked, of which two are restricted to the tenantry. It is very difficult to ascertain the actual amount of labour from the frequent interruptions of work, but it does not probably exceed a year's labour of 331 men. The average price of stone per ton is stated in the tables.

In addition to the quarries in the following tables, a general view may be given of those which are in parishes beyond the limits of the barony of Dungannon, using the same designations for building, lime, roads, &c.

Locality.	Limestone.	Old Red.	Carboniferous Grits.	Trap, Granite, &c.	Mica and other Schists.	Remarks.
Co. TYRONE.						
Errigal Keerogue	7, L. R. B.	6, B. R.	.	1, B.	.	Td. Cavey Quarry; stone 5d. per load; punched work 4d. per foot; chiselled 6d. per foot.
Cappagh .	.	1, R.	.	1, B.	1, R.B.	
Termonmaguirk .	.	4, B. R.	.	.	.	
Clogher .	6, L. B.	.	5, B.	1, B.	.	1 Calcareous band R.; B. stone 5d. to 10d. per ton; Lime 6d. per brl.
Clogherny .	.	2, B. R.	.	.	.	
Drumragh .	1, L.	.	.	.	.	2s. 1d. per ton to the public, 1s. 3d. to tenants; lime 9d. per brl.
Errigal Trough .	2, R.	3, B.	2, B. R.	.	.	
Aghalurcher .	.	.	3, B. M. G.	.	.	M. Milestones; G. Gate-posts.
Kilskeery .	.	.	1, B.	.	.	5d. per load.
Co. ARMAGH.						
Tynan . .	12, L. B. R.	.	.	.	2, B. R.	Lime 10d. per brl.
Eglish . .	2, L. B. R.	.	.	.	.	
Co. FERMANAGH.						
Enniskillen .	5, L. B. R.	2, B.	1, R.	.	.	Td. Cornagrack; hot lime 1s. 8d. per brl.; slacked 4d. per peck.
Aghavea .	1, L.	.	.	.	.	
Aghalurcher .	1, R. L.	.	.	.	.	
Cleenish .	3, L. B. R.	.	2, B. R.	.	.	
Derryvullan .	.	3, B. R.	1, B.	.	.	
Magheracross .	.	1, R.	.	.	.	
Trory . .	1, L.	.	.	.	.	
Devenish .	1, L. B. T.	.	3, B. R.	.	.	T. Tombstones.
Rossory .	1, L. R.	.	.	.	.	
Drumkeeran .	1, L.	.	.	.	.	
Magheraculmoney	2, L. R. B.	.	.	.	.	

QUARRIES.

COUNTY LONDONDERRY.

	Parishes.	Quarries		Characteristics. Schists . 1 Limestone 2 Sandstone 3 Greenstone, Basalt, &c. 4 Gravel . 5	Application. B. Building. L. Lime. R. Roads. F. Flags. Ro. Roofing. T. Tombstones. S. Sharpening stones.	Average value per ton.		Townlands in which Limestone may be procured, though at present obtained in other localities.
		Worked.	Not worked.			Kind.	Value.	
							s. d.	
BARONY OF TIRKEERAN.	Banagher .	13	2	1, 2, 3	1, B. 2, L.	2	0 11	Altinure, Lower Ballydonegan, Dreen, and Magheramore.
	Clondermot	9	29	1, 2, 3	1, B. 2, L. 1, R. 1, F. 1, Ro.	.	.	Ardkill.
	Cumber, lower	8	3	1, 2	1, 2, B. 2, L. 1, F. 1, R.	2	0 10	Brackfield, Ervey, Kildoag, and Teenaght.
	Cumber, upper	16	7	1, 2	1, 2, B. 2 L. 2 T.	2	0 11	Cregg, Cumber, Gortnaran, Stranagalwilly, and Tullintrain.
	Faughanvale	6	7	1, 2, 3	1, 3, B.	.	.	
	Total, .	52	48	—	—	.	.	
BARONY OF KEENAGHT.	Aghanloo .	3	3	2, 4	2, 4, B. 2, L.	.	.	
	Balteagh .	6	3	1, 2, 3	1, 3, 4, B. 2 L.	2	1 2	Moneyguiggy.
	Bovevagh .	6	1	2, 3, 4	2, 3, 4, B. 2, L.	2	1 1	Ardinarive and Bovevagh.
	Banagher .	See Barony of Tirkeeran.						
	Drumachose	2	2	1, 2, 3	2, L.	2	1 0	Dramramer.
	Dungiven .	10	8	1, 2, 3	2, B. 2, L.	2	0 9	Ballymakeever, Cluntygeeragh Derryork, Gortnagross, Ovil, Tirgoland, and Turmeel.
	Magilligan .	3	6	2, 4	4, B. 2, L.	2	0 10	
	T. Finlagan	1	1	1	1, B.		.	
	Total, .	31	24	—	—	.	.	
BARONY OF LOUGHINSHOLIN.	Artrea. .	8	4	2, 4, 5	2, L. 2, 4, 5, R. 2, B.	2	0 9	
	Arboe . .	.	1	2	—	.	.	
	Ballinderry	1	2	4	4, B. 4 R.	.	.	
	Ballynascreen	4	6	3	3, B. 3, F. 3, T.	.	.	Moneyneany.
	Ballyscullion	.	1	4, 5	—	.	.	
	Derryloran	2	.	3, 4, 5	3, B. 4, 5, R.	.	.	
	Desertlyn .	7	1	2, 3, 4, 5	3, 4, B. 2 L. 2, 4, 5, R.	2	0 9	Dunronan.
	Desertmartin	8	5	2, 3, 5	3, B. 2, L. 5 R.	2	1 2	Brackaghslievegallion.
	Kilcronaghan	4	2	2, 3	2, B. 2, L.	2	1 3	[The building stone sold at 9*d*. per foot.]
	Killelagh .	5	4	2, 3, 4, 5	3, 4, B. 3, F. 3, T. 3, S. 5 R.	3	.	[Flags and tombstones 19*s*. 3*d*. per ton; sharpening stones, 2*s*. and 3*s*. 6*d*. per gross.]
	Kilrea . .	1	3	4	4, B. 4 R.	.	.	
	Lissan . .	2	2	2, 3, 4	3, 4, B.	.	.	
	Maghera .	6	7	2, 3, 4, 5	4, B. 3 F. 3 S. 2 L.	2	1 3	[Flags, rough 2*d*. per foot; sharpening stones 1*s*. 3*d*. & 5*s*. per gross.]
	Magherafelt	4	8	2, 4, 5	4, B. 2, L. 4, 5, R.	2 4	0 8 0 10	
	Tamlaght .	1	2	2, 4	2, L.	2	0 10	
	Tamt. O'Crilly	3	5	4, 5	4, B. 4, R.	.	.	
	Termoneeny	.	1	2	—	.	.	Ballynahonemore.
	Total, .	56	54	—	—	.	.	
N. E. LIBERTIES OF COLERAINE.	Ballyaghran	13	22	4, 5	4, B. 4, 5, R.	.	.	
	Ballymoney	.	.	5	—	.	.	
	Ballyrashane	2	.	4	4, B.	.	.	
	Ballywillin .	16	8	4, 5	4, B. 4, 5, R.	4	0 4	
	Coleraine .	8	10	4	4, B. 4, R.	.	.	
	Kildollagh .	1	.	4	4, R.	.	.	
	Total, .	40	40	—	—	.	.	
BARONY OF COLERAINE.	Aghadowey	2	3	4, 5	4, B. 4, 5, R.	.	.	
	Agivey .	.	.	.	—	.	.	
	Desertoghill	.	2	4, 5	5, R.	.	.	
	Dunboe .	1	7	2, 4, 5	2, L. 5, R.	2	1 [illegible]	
	Errigal .	7	10	2, 3, 4, 5	4, B. 2, L. 4, 5, R.	2	1 4½	
	Killowen .	.	.	.	—	.	.	
	Kilrea . .	See Barony of Loughinsholin.						
	Macosquin .	3	3	4	4, B. 4, R.	.	.	
	Tamt. O'Crilly	See Barony of Loughinsholin.						
	Total, .	13	30	—	—	.	.	

COUNTY TYRONE.

	Parishes.	Quarries		Characteristics. Schists . 1 Limestone 2 Sandstone 3 Greenstone, Basalt, &c. 4 Gravel . 5	Application. B. Building. L. Lime. R. Roads. F. Flags. Ro. Roofing. T. Tombstones. S. Sharpening stones.	Average value per ton.		Townlands in which Limestone may be procured, though at present obtained in other localities.
		Worked.	Not worked.			Kind.	Value.	
BARONY OF DUNGANNON.	Aghaloo .	26	36	2, 3, 5	2, 3, B. 2, L. 3 F. 2, 5, R.	3	10*d* to 2*s*	
	Arboe .	1	2	2, 5	2, L. 5 R.	.	.	
	Artrea . .	3	.	3, 4	3, 4, B.	.	.	Tullyconnel.
	Ballinderry .	.	.	.	—	.	.	
	Ballyclog .	.	5	2, 4, 5	5, R.	.	.	
	Carnteel .	22	40	2, 3, 5	2, B. 2, L. 2, 5, R.	2	0 6	Legaroe.
	Clonfeacle .	12	23	2, 3, 5	2, 3, 5, B. 2, L. 2, 5, R.	2 3	0 6 0 11	
	Clonoe .	.	2	2, 3, 5	5, B. 5 R.	.	.	
	Derryloran .	8	1	2, 3, 5	2, 3, 5, B. 2, L. 2 R.	2	0 7	
	Deserteat .	19	21	1, 2, 3, 5	2, 5, B. 2, 5, L. 2, 5, R. 1, F.	1 2	12 6 0 6	Gortagowan, Cady, Gortavale, Kinyclay, Morce, and Tullyard.
	Donaghenry	20	16	2, 3, 5	2, 3, 5, B. 2, L. 2, 5, R.	2	0 4	
	Donaghmore	28	20	2, 3, 4, 5	2, 3, 4, 5, B. 2, L. 2, 4, 5, R. 3, F.	2 3	0 8 3 9	Clonavaddy and Dernaseer.
	Drumglass .	7	5	2, 3, 5	2, 3, 5, B. 2, L. 5, R.	.	.	
	Kildress .	6	2	2, 3, 4, 5	4, B. 2, L. 4, 5, R.	.	.	
	Killeeshil .	13	14	2, 3, 5	3, B. 2, L. 2, 3, 5, R.	.	.	
	Killyman .	3	.	3, 5	3, 5, B. 5 R.	3	0 9	
	Lissan . .	1	.	2, 5	2, L. 5, R.	.	.	
	Pomeroy .	16	14	2, 3, 4, 5	3, B. 2, L. 4, 5, R. 3, F.	3	0 7	
	Tamlaght .	1	2	2, 4	4, B. 4, R.	.	.	Coagh.
	Tullyniskan	4	10	2, 3, 5	3, B. 3 F. 2, 5, R.	.	.	
	Total, .	190	213	—	—	.	.	

LIME.

COUNTY LONDONDERRY.

	Parishes.	Townlands.	Trading Kilns.		Private or Pot Kilns.	Days' labour.	Quantity, Tons.	Value.		Locality of Limestone.
			General	Re-stricted.				£	s.	
BARONY OF TIRKEERAN	Banagher .	Generally .	.	.	239	.	440·5	.		Parish.
	Clondermot .	„	.	.	41	.	124·0	.		Parish and Td. Ardground; Par. Lower Cumber.
	Cumber, lower	Tamnaherin .	.	1	.	120	411·4	.		Townland.
	„	Generally .	.	.	49	.	121·7	.		Parish; and Parish Upper Cumber.
	Cumber, upper	Ballyholly .	1	.	.	504	131·2	61	5	Townland.
	„	Generally .	.	.	230	.	966·2	.		Parish; and Parish Lower Cumber.
	Faughanvale	Donnybrewer	.	1	.	.	251·8	50	0	Glenfad, County Donegal.
	„	Generally .	.	.	23	.	52·9	.		Parish; and Townland Ballyhawley.
		Total, .	1	2	582	.	2499·7	.		
BARONY OF KEENAGHT.	Aghanloo .	Generally .	.	.	1	3	4·8	2	5	Townland Tircorran.
	Balteagh .	Kilhoyle .	1	.	.	54	22·5	15	0	Townland.
	„	Generally .	.	.	4	.	25·0	.		Townland Kilhoyle.
	Bovevagh .	„	.	.	35	.	100·8	.		Parish; and Parishes Dungiven and Banagher.
	Banagher .	See Barony of Tirkeeran								
	Drumachose	Drumramer	1	.	.	735	135·0	75	0	Townland Largyreagh.
	„	Leck . .	2	.	.	1470	270·0	150	0	Townland.
	„	Generally .	.	.	5	32	28·3	13	9	Townland Largyreagh.
	Dungiven .	Ballyness .	1	.	.	288	206·0	76	0	Townland.
	„	Generally .	.	.	94	.	289·1	.		Parish; and Parish Banagher.
	Magilligan .	„	.	.	3	.	17·0	.		Parish.
	Tamt. Finlagan		.	.	.	.	.	.		None burned.
		Total, .	5	.	142	.	1098·5	.		
BARONY OF LOUGHINSHOLIN.	Artrea . .	Moneymore .	1	.	.	240	480·0	240	0	Townland.
	„	Generally .	.	.	17	58	57·3	31	9	Parishes Artrea, Desertlyn, and Tamlaght.
	Arboe . .		.	.	1	.	.	.		None burned.
	Ballynascreen	Generally .	.	.	61	.	188·8	.		Kilcronaghan and Desertmartin.
	Ballyscullion	„	.	.	30	204	212·0	110	16	Desertlyn, Artrea, and Magherafelt.
	Ballinderry .	„	.	.	2	10	4·0	2	9	Ballydawley, Parish Artrea.
	Derryloran .	„	.	.	6	41	30·6	10	12	Townlands Clare, Moneymore, and Cookstown.
	Desertmartin	„	.	.	11	206	124·7	62	4	Parish.
	Desertlyn .	Carmean .	1	.	.	313	1040·0	520	0	Townland.
	„	Gortagilly .	1	.	.	313	624·0	312	0	„
	„	Generally .	.	.	9	29	22·4	10	7	Carmean and Gortagilly.
	Kilrea . .		.	.	.	.	.	.		None burned.
	Killelagh .	Generally .	.	.	3	3	2·5	1	18	Coolsaragh, Parish Kilcronaghan.
	Kilcronaghan	Ballinderry .	.	1	.	18	14·1	4	17	Coolsaragh.
	„	Drumsamney	.	9	.	611	401·2	178	6	Townland.
	„	Killytoney .	.	2	.	81	53·4	23	15	
	„	Moyesset .	.	4	.	351	230·6	102	10	Townland Gortamney.
	„	Generally .	.	.	7	52	52·9	20	17	Parish.
	Lissan . .	„	.	.	48	100	51·8	25	17	T. Moneymore, P. Artrea; & Carmean, P. Desertlyn.
	Maghera .	Knockoneill .	1	.	.	360	329·0	69	16	Townland.
	„	Generally .	.	.	16	.	80·2	.		Ps. Artrea, Kilcronaghan, and Desertmartim.
	Magherafelt .	Ballymoghanbeg	1	.	.	313	529·3	260	0	Townland.
	„	Generally .	.	.	7	8	3·9	2	10	Townland Ballymoghanbeg.
	Tamlaght .	Ruskey, lower	1	.	.	491	800·0	400	0	Townland.
	„	Generally .	.	.	3	77	36·5	17	17	Parishes Tamlaght and Artrea.
	Tamt. O'Crilly	See Barony of Coleraine.								
	Termoneeny	Generally .	.	.	4	25	25·0	11	12	Coolsaragh; Parish Kilcronaghan.
		Total, .	6	16	225	.	5394·2	.		

COUNTY LONDONDERRY—*continued.*

	Parishes.	Townlands.	Trading Kilns.		Private or Pot Kilns.	Days' labour.	Quantity, Tons.	Value.		Locality of Limestone.
			General.	Restricted.				£	d.	
N. E. Liberties of Coleraine.	Ballyaghran .		.	.	.			.		None burned.
	Ballymoney .		.	.	.	.	.	.		"
	Ballyrashane		.	.	3	.	.	.		"
	Ballywillin .	Generally .	.	.	7	142	41·9	22	10	Ballymagarry.
	Coleraine .		.	.	.	.	.	.		None burned.
	Kildollagh .		.	.	1	.	.	.		"
		Total, .	.	.	11	142	41·9	22	10	
Barony of Coleraine.	Aghadowey .	Generally .	.	.	9	62	117·0	.		Largyreagh, Parish Drumachose.
	Agivey .		.	.	.	.	.	.		None burned.
	Desertoghill .	Generally .	.	.	3	11	15·4	[illegible]	12	Balteagh; Desertmartin; and Kilcronaghan.
	Dunboe .	"	.	.	9	.	87·2	.		Parish.
	Errigal .	Ballyrogan .	.	1	.	63	43·4	[illegible]	[illegible]	Kilhoyle, Parish Balteagh.
	"	Coolcoscreaghan	.	3	.	96	72·0	21	18	Townland.
	"	Coolnasillagh	1	.	.	90	42·0	19	5	Kilhoyle, Parish Balteagh.
	"	Generally .	.	.	12	106	75·0	90	15	Parish; and Townland Kilhoyle, Parish Balteagh.
	Killowen .		.	.	.	.	.	.		None burned.
	Kilrea .		.	.	.	.	.	.		"
	Macosquin .	Generally .	.	.	7	.	55·8	.		Keady; and Ballymagarry.
	Tamt. O'Crilly	"	.	.	12	53	63·5	40	8	Desertmartin, Kilcronaghan, Balteagh, and Desertlyn.
		Total, .	1	4	52	.	526·3	.		

COUNTY TYRONE.

	Parishes.	Townlands.	General.	Restricted.	Private or Pot Kilns.	Days' labour.	Quantity, Tons.	£	d.	Locality of Limestone.
Barony of Dungannon.	Aghaloo .	Dromore .	1	.	.	312	559·9	175	10	Townland.
	Arboe .	Carnan .	1	.	.	24	18·5	6	15	"
	"	Generally .	.	.	4	10	4·1	2	10	" Dromore.
	Artrea .	"	.	.	1	2	3·1	1	4	" Annaghone, Parish Donaghenry.
	Ballinderry .	"	.	.	4	38	9·0	8	12	" Ballydawley, Parish Artrea.
	Ballyclog .		.	.	4	.	.	.		None burned.
	Carnteel .	Armalughey	1	.	.	96	172·2	72	0	Townland.
	"	Dernabane .	1	.	.	312	559·9	195	0	"
	"	Plaister .	2	.	.	100	179·4	62	10	"
	"	Generally .	.	.	2	55	44·2	11	16	" Millix, Parish Errigal Keerogue.
	Clonfeacle .	Benburb .	2	.	.	720	1435·7	400	0	"
	"	Boland .	1	.	.	100	239·3	66	13	"
	"	Cadian .	1	.	.	720	717·8	225	0	"
	"	Drummond .	2	.	.	432	517·3	144	0	"
	"	Syerla .	2	.	.	540	807·6	225	0	"
	Clonoe .		.	.	5	.	.	.		None burned.
	Derryloran .	Cookstown .	1	.	.	1680	903·6	403	7	Townland.
	"	Gallanagh .	1	.	.	432	369·6	165	0	"
	"	Newbuildings	1	.	.	96	147·4	61	4	"
	"		.	.	1	.	.	.		None burned.
	Desertcreat .	Donaghrisk .	3	.	.	912	1440·8	529	10	Townland.
	"	[illegible] .	.	1	.	40	41·1	16	13	"
	"	Kiltyclogher .	1	.	.	484	646·9	262	10	"
	"	Generally .	.	.	147	526	309·0	116	14	Parish.
	Donaghenry .	Annaghone .	4	.	.	240	246·4	90	0	Townland.
	"	Castle Farm .	4	.	.	468	497·2	156	0	"
	"	Gortatray .	2	.	.	1140	1695·7	532	0	"
	"	Killymurphy	1	.	.	468	497·2	156	0	"
	"	Roughan .	2	.	.	768	1190·0	420	0	"
	"	Stevenson's Dowry .	1	.	.	20	81·8	10	0	"
	"	Tamnylennan	3	.	.	1512	1552·5	567	0	"
	"	Generally .	.	.	33	213	156·2	40	1	Parish.
	Donaghmore	Annaghbeg .	1	.	.	180	287·1	80	0	Townland.
	"	Finulagh .	.	1	.	168	150·7	31	10	"
	"	Gortlenaghan and Derrykeel	1	.	.	80	114·8	36	0	"
	"	Reaskmore .	.	1	.	120	143·5	30	0	"
	"	[illegible] .	1	.	.	456	545·5	152	0	"
	"	Generally .	.	.	.	454	288·3	87	13	Parish; & Townland Kilmore, Parish Pomeroy.
	Drumglass .	[illegible] .	1	.	.	360	430·7	135	0	Townland.
	"	Gortmerren .	.	1	.	120	179·4	.		"
	"	Killymeal .	3	.	.	264	1052·8	330	0	"
	"	Generally .	.	.	1	45	85·9	6	8	" Congo.
	Kildress .	Kildress, lower	1	.	.	120	410·7	166	13	"
	Killeeshil .	Generally .	.	.	236	831	595·8	153	12	Parishes Killeeshil, Carnteel, & Errigal Keerogue.
	Killyman .		.	.	.	.	.	.		None burned.
	Lissan .	Unagh .	1	.	.	216	945·0	.		Townland.
	Pomeroy .	Lisnagleer .	1	.	.	120	239·3	66	13	"
	"	Generally .	.	.	.	1313	958·3	397	18	Parishes Pomeroy, Desertcreat, and Donaghmore.
	Tamlaght .	"	.	.	6	43	22·0	11	4	Ballydawley, Parish Artrea.
	Tullyniskan .		.	.	.	.	.	.		None burned.
			48	4	.	17350	21402·2	.		

Lime.—The foregoing table, considered as a supplement to the map and preceding chapters, supplies most of the practical information required on this important mineral substance. The locality of the limestone, the places where it is burnt, the quantity of lime, and the amount of labour in producing it, so far as they could be ascertained, have been stated. The three columns, however, which contain the numbers and description of the kilns, require a few words of explanation. The kilns are first divided into trading kilns, or those which burn for sale, and pot kilns, or those which burn for private use; and the trading kilns are subdivided into those which supply lime to all buyers without distinction, and those which are either restricted in the sales to the tenants of a particular estate, or supply those tenants at a reduced price. This system of restriction is very general in the County of Derry, but more rare in Tyrone; and the principle on which it is founded appears, in many respects, unsound. A very limited power of supply may be supposed to justify a total restriction in the sale of lime to the tenants on the estate producing it; but when the power of supply is equal to any probable demand, restriction is unreasonable, and becomes a public evil. Cases of absolute restriction are comparatively rare; but the system of stipulating for a reduced price to the tenants is common, and, when examined in all its bearings, will also be often found injurious. The limeburner expects a reasonable profit, and if obliged to forego a portion of it in favor of one class of buyers, he will necessarily seek a greater profit from others, and raise the price of lime to those who, coming from a distance, have already to pay more for it in the form of carriage. When the landlord is the proprietor of the kiln, a reduced price to the tenantry is the same as a proportional allowance made for liming; but it may be doubted whether this allowance, when thus mixed up with the price, has the same stimulating effect.

The selection of proper localities and the establishment of good kilns and good systems of working are the wisest modes of interference; and it may be further suggested to great proprietors, as for example, to the London companies, who annually devote a considerable sum to local improvements, that it would be advisable, in districts not possessing limestone, to follow out the principle, already suggested in respect to coals, of establishing depôts for lime, and contracting for its transport from the nearest kilns. Bought for this purpose in considerable quantities, it might be obtained at a lower price, and, in like manner, the contract charge for its carriage would be reduced. If the principle were adopted, the use of lime would be facilitated over extensive districts in which limestone, as may be seen by referring to the map, is totally wanting. In such districts, the eagerness of the peasant to hear of limestone bears testimony to his knowledge of its value; and an additional proof of his anxiety to use it, is afforded by the fact that he sends his horse and cart perhaps ten miles for a load of stones, which he burns in a pot kiln for his own use. In doing this, there is waste of time and labour, augmented by carrying in every ton of stone, 8¾ cwt. of carbonic acid; and the sight of a cart toiling with its load of stones over a rough mountain road, or of the stones lying at the base of a rude kiln, sometimes scarcely distinguishable from the rocks surrounding it, never fails to excite a painful sense of the disadvantage of such a system. As an example of the benefits of selection, though by no means the strongest which could be cited, the establishment of a kiln on the Cullion limestone, where there is abundance of turf, would confer a considerable benefit both on the tenants of the Drapers Company and on the farmers beyond their limits; and there can be no doubt that a body, liberal and even munificent in its expenditure on building and planting, is equally disposed to apply a portion of its funds, in this and other ways, to the still more vital object of agricultural improvement. Establishments of a similar kind should be made in Bond's Glen in Lower Cumber, at Altaghoney in Upper Cumber, and in many other localities, and the use of lime extended, for it is evident (see table of analysis of soils), that whilst oxide of iron is abundant in the soil and subsoil of the schistose district, lime is remarkably deficient. These general remarks apply equally to all those parts of Tyrone and Fermanagh which are similarly circumstanced, or where limestone forms a girdle round extensive districts which do not possess it; but, in many such instances, calcareous clays and calcareous shales, when properly broken up and exposed to the air, might become valuable auxiliaries.

The pot kilns are small, rough kilns, erected by the peasantry for the manufacture of their own lime, the limestone, as before observed, being brought from a considerable distance. They contain from 20 to 80 barrels of 2 cwt. each, or from 40 to 160 cwt. The farmers sometimes adopt this system from necessity, and sometimes from a belief that the ultimate cost of the lime is less; but if the calculations were correctly made, it would appear that the supposed balance in favor of the pot kiln is generally obtained by neglecting to charge against it the labour of horse, cart, and man; the farmer replying, when this is pointed out, that if not so employed they would be doing nothing else, a reason which will give way under the growing improvement of agriculture, and the consequent necessity of economising time and labour. The farmer should keep in mind that when he buys and carts roach or hot lime, he conveys away that only which he requires; but with limestone he carries, in addition, useless carbonic acid, and with slacked lime the water, which he could have added at his own door, or in his own field. The mode of applying lime, as manure, is either alone or as a part of composts, and its use is now only limited by the occasional difficulty of procuring it, as the knowledge of its value is every day increasing. The application of sea shells has been already noticed (Chapter VI.), and the propriety of using the tertiary and detritic calcareous clays, as well as the marls of the old and new red sandstones on sandy soils, has already been sufficiently urged. There cannot indeed be a doubt that a careful attention to the real condition of the soil on the one hand, and the stratification on the other, would often point out cheap local modes of ameliorating the former. The defects of soil are more frequently due to mechanical than chemical causes, to the want or possession of some physical quality such as the power of absorbing moisture, deficient or excessive tenacity, &c., and such defects might be frequently remedied by very simple means, were the farmer to attend to the mineral constituents of the strata within his reach, marly clays being often at hand to correct the sand, and sandy or gritty beds to correct the clay.

The quantity of lime used per acre is very variable; in some cases in the County of Derry, the average of a parish is as low as 22 cwt., or 11 barrels; in others it is as high as 76 cwt., or 38 barrels; and the cost per acre varies in a corresponding manner, sinking so low as 4*s.* or 5*s.* when the lime dressing may be considered merely nominal, and rising so high as £3 12*s.* and £3 17*s.* The average quantity of shells varies, in different parishes, from 90 cwt. to 180 cwt, of which a large proportion is sand; the average cost per acre of this description of manure has risen as high as £2 12*s.*, but it is more commonly from 16*s.* to 23*s.* The value of lime generally, as a manure, is so well understood by the peasantry, that it is only necessary to sum up what may be considered its various merits, or modes of operation.

1. On boggy land, experience has fully proved that it is almost indispensable, as it not only supplies, in itself, a mineral substance, required by the useful plants intended to be grown, but also neutralizes injurious acids, and destroys sour and unprofitable plants.

2. On clay land, it assists in opening the soil, by forming lumps, or grains, of what may be called manure-concrete.

3. On sandy land, it consolidates the soil, by partially cementing the loose grains together.

These opposite modes of action, dependent, however, on a single principle, have been noticed by experienced agriculturists. Mr. Pusey remarks on the use of chalk, which is dug up from pits in Hampshire, and used unburnt—“ Hence, the chalk acts probably in two ways—chemically, by supplying the lime which was wanting; mechanically, by loosening the clay, for its application renders these hills more mellow to work with the plough. Chalk, I find, is also used largely in the wolds or chalk hills of Yorkshire, and there it is found to render loose soils more firm."—(Journal of Agricultural Society of England, Vol. III., p. 184.) This simple mode of using the softer chalk is noticed by White of Selborne, in respect to the "Malm Rock," and is also occasionally practised in Derry, along the face of the inland chalk cliff, where the lower, or marly beds, are excavated, and the lumps, when left on the ground, crumble gradually into powder. It might be advantageously adopted in many other cases, and it would sometimes be more economical to erect a small pounding mill, and break up the softer chalk, than to build a kiln and burn it. The efficacy of marl and of shells, in which the lime is present as a carbonate, sufficiently indicates that the more ordinary advantages of burning are reduction of weight for carriage, and perfect pulverization by subsequent slacking, though there may be also cases in which the active qualities of lime are assisted by its being used in a caustic state, as, for example, the quality of concreting with damp clay.

In determining on the application of lime, it is important to know what function it is intended to perform, as on that depends not only the propriety of using it, but the possibility of replacing it by a less expensive material. If the object be chemical, that is to neutralize acids and to decompose salts, to supply a necessary aliment to useful plants, or to administer a poison to the useless, it cannot be replaced with advantage. If the object be mechanical, that is, to open clayey, or to close sandy soils, it may be sometimes replaced by other mineral substances, as, for example, burnt clay and sea sand. Of these, sea sand is extensively used, but burnt clay has not yet been tried in this district.

The beds of limestone associated with the mica schists supply the lime of the western portions of Derry; the chalk that of the north-eastern portion; and the mountain limestone and chalk that of the southern portions. The mica schist limestone is usually very limited and uncertain in its development, but in Bond's Glen, Altaghoney, Park, Tamnagh, and Carn, it becomes an important member of those ancient sedimentary deposits, and might be far more extensively burnt and distributed than it is at present. The mountain limestone is the great source of supply to the counties of Tyrone and Fermanagh, and the greater extent of the manufacture and use of lime may be judged by a comparative examination of the tables.

This brief notice of the application of limestone and lime may be closed by observing, that the close and indurated texture of the Irish chalk fits it for common transfer lithography; it never, however, from its fissured condition, could be procured of sufficient size to render the application important.

Clay.—Under this head it is necessary to add but little to the information conveyed by the tables and preceding chapters. Clays well fitted for the manufacture are to be found in so many localities, that the use of bricks, as also that of draining tiles, might be advantageously extended. In those parts of the country, however, where field stones are still too abundant, they are very properly, on Mr. Smith's principle, preferred to tiles for keeping drains open, as the ground is thus at the same time externally disencumbered of the superfluous stones, and internally improved: drains of this description require, however, a good fall, as the stones are subject to be cemented together by the ferruginous matter, just as the subsoil gravel has been.

The old pottery of the parish of Faughanvale, townland of Longfieldbeg, has been abandoned as a manufactory of earthenware, and in part directed to this object. The general manufacture is increasing, as is seen in the following recent return by Mr. Wiggins: "We find it does not answer to make much ware for sale at our kiln. The pottery is now entirely abandoned, but we make and use on the estate 50,000 bricks yearly, and about 20,000 draining tiles; also about 500 feet of ridge tiles for slated roofs; also from 4000 to 5000 flooring tiles, nine inches square and three inches thick; and about 5000 cornice bricks for the eves of slated roofs, which are fixed into a notch in the front of the stone wall under the wall plate, with which they are connected by a toe rafter, the slating being thus sufficiently continued beyond the wall to secure it from drip. The same description of brick is also used for facing the openings of doors. The draining tiles are about fifteen inches long, and are worth about 30*s*. per thousand on the spot; the bricks cost about £1 per thousand; the flooring tiles about £1 per hundred. We also make yearly 2000 to 3000 pantiles for roofing, about fourteen inches by ten inches, which cost about £4 per thousand, and two hundred cover one square of roofing. The ridge tiles cost about 2*d*. per foot. A cargo of draining tiles lately arrived at Derry from Scotland, each about twelve inches long; the price demanded for them was 25*s*. per thousand, but they were ultimately purchased by Mr. Anthony Babington, of Crevah, for 21*s*. per thousand." This statement is a confirmatory proof of the progressive improvement of the agricultural tenantry of the Grocers' estate, under a system in which attention is first directed to the essential object of bettering the condition of the peasantry.

In Tyrone, also, a gradually increasing attention is paid to the manufacture of tiles, both for draining and other purposes. In Ballynakilly, Killyman parish, 8000 draining tiles were made at Mrs. Robinson's establishment; they were twelve inches long, and charged at 27*s*. per thousand. In Brackaville, Donaghenry parish, at Mr. Newburn's, 4000 flooring tiles, at 2*d.* each, 400 ridge tiles, at 3*d.* each, and 5000 fire bricks, at £2 per thousand, were manufactured in a kiln which had formerly been used in the pottery, now for some years abandoned. In Drumenagh, Killyman parish, at Mr. Kilpatrick's, 6000 draining tiles, twelve inches long, were made, and supplied to Colonel Verner, at 30*s.* per thousand. Mr. Lloyd has also commenced an extensive tile manufactory near Verner's Bridge, and a few draining tiles, principally for home use, were made at several of the Coal Island establishments; yet how insignificant are these preparations for the most important of all agricultural operations, when compared with the efforts making in other countries, already supposed to have attained a high state of cultivation and improvement. Mr. Pusey quotes the following statement of Mr. Beart, of Godmanchester, the inventor of a simple tile-making machine:—

"The price of furrow-draining tiles has fluctuated from 20*s.* to 22*s.* per thousand: at these reduced prices, the consumption of tiles has increased greatly. As a proof of that increased consumption, and of the great quantity manufactured, it was publicly stated, at a late meeting of agriculturists at Huntingdon, that one tenant-farmer last year consumed 520,000 draining tiles;" and it is stated by the manager of the Tweeddale patent drain-tile and brick manufactory—"It may, indeed, be some evidence of their estimation in the agricultural world to state, that we have this year made upwards of twenty millions of draining tiles and soles."

The Tweeddale tiles are made fifteen inches long, and the price varies, according to the price of coals, from 25*s.* to 45*s.* per thousand, the average being higher than the price of those manufactured of a similar size at the Grocers' kiln. The price of a hand tile-machine, on the Tweeddale patent, is £45, and, with it, two men and one boy can easily make 500 draining-tiles, fifteen inches long, per hour. The seignorage is 1*s.* on any number up to 100,000, made in any one season, and diminishes proportionately with greater numbers. What a field, then, for improvement is here opened to the enterprising and liberal proprietor. "We should be encouraged," says Mr. Pusey, "by knowing what we have done, if, indeed, we have succeeded in anything; we shall be more likely to advance farther, if we look at the difficulties we still have to deal with; and the best encouragement, perhaps, for active men, is the knowledge that they have yet a great deal to do."

Some proprietors may, perhaps, be unwillingly restrained, in this class of improvement, by defective means; but in Derry there are many not so circumstanced, and amongst them the London companies. The Grocers have set an example, and ere long it will be, doubtless, followed by the intelligent agents of the other companies.

The potteries of Coal Island, and of the tertiary deposit generally, might be increased to any extent which the demand would warrant. The clay is usually obtained from excavations three, four, and sometimes thirty feet deep, and, in like manner, the Stourbridge clay of the coal measures is ample to supply any probable demand. The ware is burnt in ovens or kilns, which contain about eighty-five pieces, and are replenished fifty or sixty times per annum, the whole process occupying about ten days. The growing facility of communication with Belfast by Lough Neagh and the Ulster railway will, ere long, have the effect of augmenting a manufacture in places so favorably situated both for material and fuel. The manufacture is extremely simple. The oven, or kiln, is cylindrical for about five feet from the foundation, and then arched or domed over, a circular opening being left at the top as a flue to give vent to the fire. In each quadrant of the kiln, there is an opening called an eye, or fire-hole, which is screened inside by a semi-circular partition, perforated by twelve or more small fire-holes, two or three inches in diameter, through which the fire or flame passes. On the outside, also, of each of the eyes, or large fire-holes, a niche is formed to receive the fuel, and is called a fire-bag. The ware is introduced by a door in the side. The kiln is surrounded by an external building, through the top of which a large chimney is carried up from the flue of the oven. The fat clay, procured at depths varying from 6 to 30 feet, is nearly white, and is mixed with a meagre or sandy clay, of a yellowish tint, obtained at a depth of about two feet. The yellow clay is mixed with the white in the proportion of 1 to 3, or 1 to 4. The clay, when mixed, is soaked or soured for 12 hours; it is then tramped on the floor by two men, beginning at the edge of the heap, and working in towards the centre. After this process, it is cut by little wooden shovels into thin slices, again thrown into a heap, and once more tramped upon. When it has been fully worked, or tempered, it is weighed out into lumps corresponding to the articles to be made—(See Pottery Table.) The ware is fashioned on the ordinary potter's wheel, turned by a hand crank. It is dried on boards in the smaller, and in regular drying-houses in the larger establishments. Both men and women are employed: their daily wages are—Potter, 2*s.*; male assistant, 10*d.*; female ditto, 5*d.* Lead and Manganese are both used in the glazing, and it may, perhaps, be useful to give the proportions adopted in Paris for potter varnishes, or glazes:—

Green Varnish—Minium, 65 parts; clay, 16; sand, 16: oxide of copper, 3.
Brown Varnish—Minium, 64: clay, 15; sand, 15; German manganese, 9.
Yellow Varnish—Minium or litharge, 70; clay, 16; sand, 14.

The further advantage of making pipes or cylinders for the manufacture of sulphur from iron pyrites will be noticed under the head of Application of Coal.—(Page 685.)

CLAY.

COUNTY LONDONDERRY.

	Parishes.	Townlands.	Kilns.	Days' labour.	Fuel. Turf. Loads.	Fuel. Turf. Value.	Fuel. Coals. Tons.	Fuel. Coals. Value.	Product. Brick.	Product. Fire Brick.	Product. Fire Blocks.	Product. Flooring & Ridge Tiles.	Product. Value.
						£ s.		£ s.					£ s.
BARONY OF TIRKERRAN.	Banagher	.	.	.	.	.	.	.	.	.	.	.	.
	Clondermot	.	.	.	.	.	.	.	.	.	.	.	.
	Cumber, lower	.	.	.	.	.	.	.	.	.	.	.	.
	Cumber, upper	.	.	.	.	.	.	.	.	.	.	.	.
	Faughanvale	Longfieldbeg	2	1565	.	.	.	.	85,000	.	.	16,700	261 0
		Total,	2	1565	.	.	.	.	85,000	.	.	16,700	261 0
BARONY OF KEENAGHT.	Aghanloo	.	.	.	.	.	.	.	.	.	.	.	.
	Balteagh	.	.	.	.	.	.	.	.	.	.	.	.
	Borevagh	Derryard	1	80	60	2 0	.	.	21,000	.	.	.	11 11
	,,	Flanders	1	69	50	2 2	.	.	20,000	.	.	.	10 0
	Banagher	.	.	.	.	.	.	.	.	.	.	.	.
	Drumachose	Ardgarvin	1	197	60	6 17	.	.	60,000	.	.	.	80 0
	Dungiven	.	.	.	.	.	.	.	.	.	.	.	.
	Magilligan	.	.	.	.	.	.	.	.	.	.	.	.
	Tamlt. Finlagan	Drumballydonaghy	2	516	150	7 10	.	.	150,000	.	.	.	90 0
	,,	Moneygrannel	1	344	100	12 10	.	.	100,000	.	.	.	65 0
	,,	Tamlaght	1	275	80	10 0	.	.	80,000	.	.	.	52 0
	,,	Tully	2	289	84	10 10	.	.	84,000	.	.	.	54 12
	,,	Tullyhoe	1	241	70	8 15	.	.	70,000	.	.	.	49 0
		Total,	9	2011	654	60 4	.	.	585,000	.	.	.	362 3
BARONY OF LOUGHINSHOLIN.	Artrea	Derrygarve	2	138	85	4 5	1·7	1 6	35,000	.	.	.	21 0
	Arboe	Drummullan	3	303	88	8 16	·9	0 14	59,000	.	.	.	42 3
	Ballynascreen	.	.	.	.	.	.	.	.	.	.	.	.
	Ballyscullion	Leitrim	3	530	90	5 0	7·7	3 17	145,000	.	.	.	86 7
	Ballinderry	.	.	.	.	.	.	.	.	.	.	.	.
	Derryloran	.	.	.	.	.	.	.	.	.	.	.	.
	Desertlyn	.	.	.	.	.	.	.	.	.	.	.	.
	Desertmartin	.	.	.	.	.	.	.	.	.	.	.	.
	Killelagh	.	.	.	.	.	.	.	.	.	.	.	.
	Kilrea	Claragh	2	819	840	42 0	.	.	336,000	.	.	.	176 8
	Kilcronaghan	Tobermore	1	74	14	0 14	.	.	14,000	.	.	.	5 19
	Lissan	.	.	.	.	.	.	.	.	.	.	.	.
	Maghera	Ballynahonebeg	8	709	179	8 2	.	.	188,000	.	.	.	67 16
	,,	Curran	1	70	15	0 15	.	.	18,000	.	.	.	6 15
	Magherafelt	.	.	.	.	.	.	.	.	.	.	.	.
	Tamlaght	.	.	.	.	.	.	.	.	.	.	.	.
	Tamlt. O'Crilly	.	.	.	.	.	.	.	.	.	.	.	.
	Termoneeny	.	.	.	.	.	.	.	.	.	.	.	.
		Total,	20	2643	1311	69 12	10·3	5·17	795,000	.	.	.	406 8
N. E. LIBERTIES OF COLERAINE.	Ballyaghran	.	.	.	.	.	.	.	.	.	.	.	.
	Ballymoney	.	.	.	.	.	.	.	.	.	.	.	.
	Ballyrashane	.	.	.	.	.	.	.	.	.	.	.	.
	Balywillin	.	.	.	.	.	.	.	.	.	.	.	.
	Coleraine	.	.	.	.	.	.	.	.	.	.	.	.
	Kildallagh	.	.	.	.	.	.	.	.	.	.	.	.
			.	.	.	.	.	.	.	.	.	.	.
BARONY OF COLERAINE.	Aghadowey	.	.	.	.	.	.	.	.	.	.	.	.
	Agivey	Mullaghmore	1	594	480	20 0	.	.	160,000	.	.	.	80 0
	Desertoghill	.	.	.	.	.	.	.	.	.	.	.	.
	Dunboe	.	.	.	.	.	.	.	.	.	.	.	.
	Errigal	.	.	.	.	.	.	.	.	.	.	.	.
	Killowen	.	.	.	.	.	.	.	.	.	.	.	.
	Kilrea	See Barony of Loughinsholin.					.	.	.	.	.	.	.
	Macosquin	.	.	.	.	.	.	.	.	.	.	.	.
	Tamlt. O'Crilly	.	.	.	.	.	.	.	.	.	.	.	.
		Total,	1	504	480	20 0	.	.	160,000	.	.	.	80 0

COUNTY TYRONE.

	Parishes.	Townlands.	Kilns.	Days' labour.	Fuel. Turf. Loads.	Fuel. Turf. Value.	Fuel. Coals. Tons.	Fuel. Coals. Value.	Product. Brick.	Product. Fire Brick.	Product. Fire Blocks.	Product. Flooring & Ridge Tiles.	Product. Value.
BARONY OF DUNGANNON.	Agha'oo	.	.	.	.	.	.	.	.	.	.	.	.
	Arboe	Ballymurphy	4	150	25	2 2	8·0	3 12	27,000	.	.	.	23 13
	Artrea	Edernagh	2	102	22	1 17	·3	0 5	17,000	.	.	.	11 2
	Ballinderry	Derrycrin Conyngham	2	177	20	2 0	12·0	5 8	18,000	.	.	.	13 10
	Ballyclog	Drumbanaway	1	103	12	1 10	5·0	2 14	30,000	.	.	.	25 0
	Carnteel	Lisdoart	1	248	60	6 0	1·5	1 0	60,000	.	.	.	51 0
	,,	Shantavny	1	244	40	4 0	2·0	1 7	60,000	.	.	.	52 10
	Clonfeacle	Drumgrannon	1	159	10	1 10	14·0	8 8	40,000	.	.	.	37 0
	,,	Tullygoney	1	154	12	1 16	12·5	7 6	40,000	.	.	.	40 0
	Clonoe	Aughamullan	1	84	10	0 10	3·0	1 5	20,000	.	.	.	16 13
	Derryloran	Coolkeeghan	1	229	24	2 0	8·0	4 13	45,000	.	.	.	42 0
	,,	Strife Hill	8	389	37	3 14	18·0	7 2	73,000	.	.	.	53 17
	Desertcreat	.	.	.	.	.	.	.	.	.	.	.	.

COUNTY TYRONE—*continued.*

	Parishes.	Townlands.	Kilns.	Days' labour.	Fuel.				Product.				
					Turf.		Coals.		Brick.	Fire Brick.	Fire Blocks.	Flooring & Ridge Tiles.	Value.
					Loads.	Value.	Tons.	Value.					
						£ s.		£ s.					£ s.
BARONY OF DUNGANNON—*continued.*	Donaghenry .	Brackaville .	1	63	15	1 17	3·0	1 0	20,000	.	.	.	16 0
	„	Mullaghmoyle .	1	.	15	1 17	4·0	1 13	30,000	.	.	.	22 10
	Donaghmore .	Annaghbeg .	1	.	20	1 0	20·0	12 0	60,000	.	.	.	52 10
	„	Edenacrannon .	1	93	20	1 0	6·0	3 4	20,000	.	.	.	17 10
	„	Tullyallen . .	1	.	20	1 0	6·0	3 4	20,000	.	.	.	18 0
	„	Tullyaran . .	1	104	30	1 10	8·0	5 0	40.000	.	.	.	30 0
	Drumglass .	Drumcoo . .	1	.	40	2 13	60·0	23 0	165,000	.	.	.	148 10
	„	Lurgaboy . .	1	.	10	0 15	10·0	5 0	30,000	.	.	.	27 15
	Kildress . .	Clare . .	1	122	40	2 0	3·0	1 3	30,000	.	.	.	19 10
	Killeeshil . .	. . . .	.	.	.	.	.	.	.	.	.	.	.
	Killyman . .	Drumard Glebe	1	94	20	1 0	6·0	3 2	20,000	.	.	.	16 0
	„	Drumenagh .	1	.	30	3 0	12·0	6 4	40,000	.	.	.	30 0
	„	Tamlaghtmore	1	.	12	1 0	15·0	9 15	50,000	.	.	.	62 10
	„	„	1	.	240	12 0	.	.	.	.	.	36,000	63 0
	Lissan . .	. . . .	.	.	.	.	.	.	.	.	.	.	.
	Pomeroy . .	. . . .	.	.	.	.	.	.	.	.	.	.	.
	Tamlaght . .	Coagh . .	1	59	6	0 12	4·0	1 16	6,000	.	.	.	4 4
	„	Drumad . .	1	55	6	0 12	3·0	1 7	4,000	.	.	.	2 16
	Tullyniskan .	Derry . .	1	360	80	3 7	20·0	6 13	100,000	.	.	.	75 0
	„	„	3	4,284	5,100	212 10	510·0	170 0	.	346821	1,500	79,055	1322 0
	„	Gortgonis . .	1	1,584	960	32 0	80·0	26 13	.	56000	1,200	12,800	413 7
	„	Gortnaskea	1	256	20	1 5	14·0	4 13	70,000	.	.	.	52 10
		Total, .	39	.	6,956	307 17	863·3	328 12	1135000	402821	2,700	127,855	2,759 17

POTTERIES.

COUNTY LONDONDERRY.

	Parishes.	Townlands.	Kilns.	Days' labour.		Fuel—Turf.		Value of extraneous materials.	Product.	
				Of Men, Boys, &c.	Of Horses.	Loads.	Value.		Quantity, dozens, or pieces.*	Value.
							£ s.			£ s.
BARONY OF LOUGHINSHOLIN.	Ballyscullion . .	Leitrim . . .	12	4,032	.	562	41 6	102 15	6,061	424 16
	„	Oldtown Deerpark .	1	144	.	18	1 4	2 4	144	12 0
		Total, . .	13	4,176	.	580	42 10	104 19	6,205	436 16
BARONY OF COLERAINE.	Aghadowey . .	Glenkeen . . .	1	234	.	50	3 2	5 4	350	35 0
	Agivey . . .	Landagivey . .	2	408	.	62	4 6	6 3	491	50 12
	„	Mullaghmore . .	1	312	.	25	3 2	4 3	300	42 10
		Total, . .	4	954	.	137	10 10	15 10	1,141	128 2

COUNTY TYRONE.

	Parishes.	Townlands.	Kilns.	Of Men, Boys, &c.	Of Horses.	Loads.	Value.	Value of extraneous materials.	Quantity, dozens, or pieces.*	Value.
BARONY OF DUNGANNON.	Clonoe . . .	Annaghmore . .	1	2,320	40	480	36 0	100 10	6,400	320 0
	Tullyniskan . .	Creenagh . .	3	4,272	26	674	67 8	151 5	10,360	640 0
	„	Gortgonis . .	1	2,040	20	340	34 0	68 0	5,440	340 0
	Killyman . .	Ballynakilly . .	3	2,424	60	600	57 10	116 8	4,400	376 13
	„	Corr . . .	2	3,972	34	703	64 9	145 5	10,770	628 5
	„	Drumenagh .	3	2,796	50	800	80 0	127 13	10,000	583 7
		Total, . .	13	17,824	230	3,597	339 7	709 1	47,370	2888 5

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* In Tyrone, the ware is estimated by pieces, the clay, when properly worked, being formed into balls or cakes, the weight of which corresponds to the description of article to be made. A crock or pan, requiring 30 lbs. of raw clay, is called a half-piece crock ; one of 6 to the piece requires 10 lbs. ; one of 10 to the piece, 6 lbs., and so on, the piece being 60 lbs. In Derry, the ware is estimated by dozens, or the actual number of the articles of all kinds made.

SULPHATE OF BARYTES.—In the manufacture of finer pottery, such as the Wedgewood ware, this mineral enters as an important ingredient, and is here mentioned as another source of profitable industry to the country. It is abundant in the old red sandstone district.—See Chapter XI.

OCHRE.—The localities and application of this mineral have been detailed in Chapter VII.

COAL—*Application.*—In Chapter XII. the ordinary statistics of the collieries have been given, and it is only intended to notice here such beneficial applications of capital and power as are consequent on the proximity of coal. One of these is the extensive spade manufactory of Stewart Leckey, Esq., established in Gortgonis townland (Coal Island) in the year 1834. The power is obtained by undershot water wheels, of which there are three, of the following dimensions:—

1st.	12 feet diameter;	4 feet width of bucket;	moves a hammer.
2nd.	12 „	3 „	„
3rd.	8 „	2 „	moves the bellows.

Of hammers, there are two, one weighing $5\frac{1}{2}$ cwt.; the other $4\frac{1}{4}$ cwt. Of bellows, two pair, moved by the lesser water wheel. Of men, 2 plaiters and 4 helpers, 5 finishers and 5 helpers. The time actually employed per annum is about 40 weeks. The product and value may be thus stated:—

Spades,	1,600 dozen at 24*s.* per dozen,	£1,920 0	
Turf Spades,	6 „ 24*s.* „	7 4	
Shovels,	16 tons at 32*s.* 6*d.* per cwt.	520 0	
Spade Shafts,	1,607 dozen at 4*s.* per dozen,	321 8	
			£2,768 12

MATERIALS USED.

Iron, 1,110 cwt. at 10*s.* 6*d.* per cwt.,	£582 15	
Steel, 91 „ 30*s.* „	136 10	
		£719 5

Market for materials, Bristol, and rarely Newry; market for sales, general in the north of Ireland. The workmen are paid by the piece, Mr. Leckey allowing to the foremen 1*s.* 8*d.* per dozen for plaiting, and 4*s.* per dozen for finishing turf and common spades: and for shovels, 4*s.* 10*d.* per cwt. for plaiting and steeling, and 4*s.* for finishing.

The foremen employ their own helpers, and pay them 6*d.* per dozen for plaiting, 1*s.* per dozen for finishing spades; 1*s.* 10*d.* per cwt. for plaiting and steeling, and 1*s.* per cwt. for finishing shovels. This establishment is well conducted, and appears to be in full employment. The water power has been hitherto found amply sufficient, and the possession of cheap fuel is an advantage which ensures the successful prosecution of this branch of industry.

There is also an extensive mill, but it cannot be considered a result of the collieries.

IRON PYRITES.—At present no attempt has been made in the north of Ireland to apply this mineral to a useful purpose, although there is probably no spot in the kingdom so well fitted for the manufacture of sulphur and sulphuric acid as the Dungannon coal district. The iron pyrites of Wicklow was profitably worked under the stimulus of the Sicilian monopoly and the high prices consequent upon it; the manufacture, however, could be there carried no farther than the preparation of the mineral by breaking it up and washing, and it was then shipped to Swansea. In this district every branch of the manufacture might be carried on successfully, as there is coal for distilling the mineral and clay for the manufacture of the earthen pipes or cylinders used as retorts. With a view, therefore, to draw attention to the subject, so that an inquiry may be made, how far, under the present circumstances of the sulphur trade, the manufacture could be established with advantage, I shall give a brief sketch of the mode of manufacture. Iron pyrites is the bi-sulphuret of iron, containing one atom of iron and two atoms of sulphur, or in every hundred pounds weight 45¾ pounds of iron and 54¼ pounds of sulphur nearly. It is abundantly distributed in the mineral kingdom in cubical or dodecahedral crystals, either isolated, or united into a confused mass. M. Becquerel has succeeded in forming it by the galvanic process, a fact which is of interesting application in considering the nature and origin of the crystals disseminated in rocks. In using the mineral for the manufacture of sulphur, the following particulars should be attended to. If half the sulphur be extracted, the remaining constituents will be so arranged as to form protoxide of iron and sulphuric acid, and by combining together, sulphate of iron. If, therefore, 27 of the 54 pounds of sulphur contained in 100 of pyrites could be extracted, the formation of sulphate of iron would not be impeded, and in consequence the object is to separate this superfluous quantity of sulphur. By the application of heat about 21 or 22 pounds may be extracted; but this can only be done at a temperature sufficient to fuse the residue, which is sulphuret of iron, or a compound of one atom of iron and one atom of sulphur; a circumstance which must be carefully avoided, as it would be necessary to break up the apparatus in order to extract the fused mass. Experiment has shown that 13 or 14 pounds may be extracted, and the residue is then pulverulent and easily removed. The manufacture is general in Saxony and Bohemia, and has also been introduced into France by M. Dartigues. The Saxon and Bohemian method is to arrange across a furnace (de galère) earthenware tubes, which project a little beyond the wall of the furnace. The tubes are narrower at one end, and gently inclined (by a slope of about one inch) towards that end. The narrow and most inclined end is secured by a perforated plug, which prevents the descent of the mineral whilst it allows a free passage or flow to the sulphur and its vapour. Another earthenware tube is adapted to the end of the distilling tubes, and conducts the sulphur to a receiver filled with water, where it is condensed. The receiver is made of wood, and covered with a plate of lead, pierced at top to allow a passage to the dilated air within. The tubes are then charged with the mineral at the larger opening, which is secured by an earthenware plate well luted on. The distillation now commences, and as the disposition of the tubes permits the sulphur to flow readily, a high temperature is not required through the whole extent of the tubes; but at the same time, the sulphur is liable to be mixed with impurities

Each furnace is provided with from 12 to 24 tubes, and the charge for each tube is 27½ pounds of the mineral. The distillation lasts eight hours, and in a furnace containing 24 tubes 63 cwt. of the mineral are distilled per week, and 8½ cwt. of sulphur obtained, that is, about 14 pounds per hundred. M. Dartigues, in his manufactory near Namur, has so far modified the process as to use cylindrical tubes, and to arrange them horizontally. The charge of each tube is 55 pounds, the distillation lasts six hours; 168 cwt. of mineral are acted upon, and 23 hundred weight of sulphur obtained per week, the product being from 13 to 14 pounds per hundred.

As only a portion of the superfluous sulphur is obtained by this process, the residue is not a compound of single atoms of the constituents, but consists of two atoms of iron and three atoms of sulphur; whence it follows that the residual sulphuret corresponds to the peroxide of iron, and it might be supposed that peroxidation of the iron and acidification of the sulphur should result in the formation of a neutral sulphate of the peroxide of iron; in practice, however, the residue, when exposed to the air, is found to yield a sulphate of the protoxide.

M. Dumas, from whose work (" Traité de Chimie appliquée aux Arts") this description has been adopted, observes: " This method of extracting sulphur is simple, but to effect it with a profit, it is necessary that good earthenware tubes and fuel should be procurable at a low price, and iron pyrites in abundance." In respect to these essential requisites, coal and excellent clay are on the spot, and there is little doubt that an ample supply of pyrites would be brought in were a manufactory once set on foot. Of known localities of supply may be mentioned a deposit in the tertiary clay near the spade mill at the wood of Belville, near Stewartstown, where pyrites is found in large crystalline lumps; another behind the demesne of Pomeroy, on the river bank, where it is abundant in a massive bed of the silurian epoch, and machinery could be easily erected for washing and breaking it. In Dirnan townland, near Moneymore, it occurs in aggregates of small crystals. It is frequent in the shales, and there can be little doubt that a demand once created would soon induce the peasantry to seek for and prepare it as a useful auxiliary branch of industry. Of all the localities, however, the first, should the pyrites on full investigation prove as abundant as it now appears, is the most promising. from its proximity to the proper site of manufacture, and the existence of a small spade manufactory, which might be easily converted into a washing and pounding apparatus. It is to be hoped that these remarks may attract attention to the subject. The manufacture might be carried on to its final result in sulphuric acid, but it is unnecessary to detail the process of this latter operation, as it is already well known and practised in Belfast. The present price of sulphur is 18*s*. per cwt.

No. IV.

SOILS.

THE accuracy of Professor Johnston's observation cannot be doubted, that the cause of great fertility, or of remarkable infertility in soils, if dependent on the presence or absence of some particular mineral salt essential in a very minute quantity to the right constitution of peculiar plants, can only be ascertained by the most accurate analysis, still careful examinations of soils, though not carried out to an ultimately rigid analysis, are useful in discovering the more marked deficiencies, and indicating the causes of the physical qualities of the soil. The table here given is only part of a design, as it was intended to examine the soils of all the parishes, and to perfect the inquiry by a rigid analysis of the soluble and insoluble matter in a sufficient number of cases to have given a clear view of the general condition and qualities of the soils. The analyses were made on 200 grains, and were carefully conducted, using a good common, but not a refined balance. The four first columns of figures afford a tolerable clue to the physical qualities of the soils, which had been kept and dried in a warm atmosphere, the quantity of water expelled by ignition being, therefore, a measure of the absorbing and retentive quality of the soil, which varies with the quantity of organic matter, of fine insoluble matter, or of peroxide of iron. The quantity of alumina and of peroxide of iron, in a free or soluble state, is considerable; and this condition is more uniform than it would otherwise have been, from the great spread, over the north-western portion of the County of Derry, of a detritus principally composed of schist, which thus modifies the character of the more limited sandstone district. The quantity of lime in some of the soils is very small; but this also corresponds to the composition of many of the schists, and indicates the propriety of using lime as a corrective of physical defects. In one case, where chalk and new red marls are at hand, the soil is highly calcareous, containing 40 per cent. of carbonate of lime. In looking at this table, the general character of the soil might, from the columns of water, organic matter, sand and gravel, and fine insoluble matter, be predicated with tolerable precision; the water and organic matter show the absorbing quality, the sand and gravel the loose or open character, the fine insoluble matter the close or clayey; and in like manner, the subsoil will, in a great measure, prove a close impervious till, or iron-bind, in proportion to the quantity of peroxide of iron. Many other interesting deductions might be made, but at present it is sufficient to observe that, though the actual presence of particular substances is essential to vegetable life, and to the perfecting of plants, the physical condition, resulting from the combination of the more prominent constituents of the soils, is, in reality, the principal modifying cause of their fertility. The practice of Tull would, indeed, be amply sufficient to prove this, although it is also true that the frequent exposure of new surfaces by repeated ploughing must have accelerated the decomposition of mineral compounds, and supplied, therefore, the necessary elementary substances in greater quantities.

COUNTY OF LONDONDERRY.—Composition of Soils.

Parish.	Townland.	Mountain. Upland. Lowland.	Nature of Rock.	Water.	Organic Matter.	Sand and Gravel.	Fine Insoluble Matter.	Oxide of Iron.	Alumina.	Carbonate of Lime.	Total.
Ballynascreen	Coolnasillagh .	M.	Sm. 2 Ax.	8·6	10·8	98·4	73·6	1·5	1·1	·2	194·2
,,	Doon . .	,,	2 Ax.	7·8	11·2	124·5	53·2	4·5	·7	·2	202·1
,,	Drumard .	U.	2 A. 3 A.	7·9	8·7	115·7	59·3	3·2	1·4	·2	196·4
,,	Gortnaskey .	L.	3 A.	8·5	8·2	105·4	62·3	5·0	2·4	·2	192·0
,,	Moneyguiggy .	,,	3 A.	8·2	8·4	136·2	37·2	4·6	1·1	·2	195·9
,,	Moyard . .	M.	Sm.	9·6	11·8	104·2	65·8	7·1	·7	·2	199·4
Ballyscullion	Ballymacombsbeg	L.	T.	24·3	22·6	71·3	54·6	16·4	5·5	.	194·7
,,	Ballymacombsmore	,,	T.	20·2	21·0	73·3	60·8	15·1	4·8	.	195·2
,,	Ballynease Macpeake	,,	T.	21·2	20·2	85·9	49·0	10·7	5·5	6·3	198·8
,,	Drumanee, Upper	,,	T.	18·6	15·6	68·3	73·7	12·8	5·2	.	194·2
,,	Edenreagh .	,,	T.	15·5	13·4	97·0	55·9	8·8	5·7	.	196·3
,,	Oldtown Downing	,,	T.	19·6	17·9	68·2	70·8	10·3	6·0	3·6	196·4
Banagher .	Ballydonegan .	M.	Sm.	9·4	16·5	132·8	30·1	7·7	3·2	.	199·7
,,	Ballyhanedin .	L.	Sm.	8·5	20·8	131·7	37·0	3·1	6·0	.	207·1
,,	Derrychrier .	,,	2 Ax.	12·2	21·6	123·8	38·2	3·9	2·1	·2	202·0
,,	Fincarn . .	M.	Sm.	21·6	8·8	106·8	26·0	26·5	7·5	4·3	201·5
,,	Kilcreen . .	,,	Sm.	9·6	10·2	116·8	51·3	6·8	2·0	.	196·7
,,	Killunaght .	,,	Sm.	15·8	24·0	101·2	38·7	·2	2·7	.	182·6
Dungiven .	Curraghlane .	,,	4 A. 6 L. T.	12·9	11·0	16·4	70·6	4·5	1·3	85·1	200·9
,,	Eden . .	,,	T.	6·6	2·9	85·6	77·4	11·7	5·3	9·3	198·8
,,	Glenshane .	,,	T. 3 A.	5·0	6·7	164·6	23·8	4·0	1·4	.	205·5
Faughanvale .	Carnakilly, Upper	U.	Sm.	9·4	11·5	88·8	75·1	6·2	3·3	.	194·3
,,	[illegible] .	M.	Sm.	4·2	5·5	106·7	75·3	6·6	4·2	.	202·5
,,	[illegible] .	L.	D.*	6·7	10·8	126·3	43·6	6·3	2·2	.	195·9
,,	Donnybrewer .	,,	D.* Sm. 3A.?	11·6	16·3	107·2	51·7	6·1	2·0	.	194·9
,,	[illegible] Glebe.	M.	Sm.	12·6	14·3	75·7	92·5	10·4	3·3	.	208·8
,,	Glassakeeran .	,,	Sm.	6·8	1·5	110·4	72·6	6·7	2·5	.	200·5
,,	Killywool .	,,	Sm.	7·4	11·6	86·9	84·0	7·0	1·8	.	198·7
,,	Longfieldmore .	L.	D.*	7·1	11·5	121·9	51·4	4·5	2·4	.	198·8
,,	Minegallagher .	U.	Sm.	7.8	12·8	115·6	49·2	6·6	3·3	.	195·3
,,	Moneyhanegan .	M.	Sm.	3·2	6·0	112·0	67·8	8·0	3·0	.	200·0
,,	Monnaboy .	U.	Sm.	12·6	10·4	80·3	90·9	5·8	2·7	.	202·7
,,	Tullyvery .	L.	3 A.	5·5	7·3	142·9	38·6	6·2	.	.	200·5
Killelagh .	Ballyknock .	M.	Sm. 3 A.	24·6	16·9	44·5	82·7	14·4	9·6	·7	193·4
,,	Granaghan .	Hilly	T.	14·2	13·3	89·1	57·1	6·6	2·6	·7	193·6
,,	Moneysharvan .	,,	T.	12·8	11·7	96·0	59·7	9·5	4·4	·7	194·8
,,	Slaghtneill .	M.	T.	25·2	15·1	41·9	88·6	17·6	5·9	·7	195·0
,,	Tirhugh .	,,	T.	12·0	14·5	93·2	65·1	6·4	4·3	·7	196·2
Maghera .	Brackaghreilly .	H.	3 A.	5·4	9·0	137·0	41·4	4·3	2·1	·7	199·9
,,	Curran . .	L.	T.	14·7	16·9	100·6	36·5	8·9	14·8	7	193·1
,,	Knockoneill .	H.	Sm. Lg.	17·0	23·0	110·9	25·7	6·7	9·5	·7	193·5
,,	Tirnageeragh .	L.	T.	22·0	21·3	63·1	65·3	2·3	17.8	·7	192·5
,,	Tullykeeran .	U.	T.	7·2	11·5	142·2	28·5	9·0	·3	·7	199·4
Tamt. Finlagan	Ardnargle .	L.	D.* 3 A.?	6·6	10·6	24·7	130·2	10·5	trace	.	182·6
,,	Ballymacran .	,,	D.* 3 A.?	7·2	9·4	110·8	61·1	.	.	1·5	190·0
,,	Mullagh . .	,,	Sm.	12·1	9.2	110·4	58·6	7·6	2·9	.	200·8

* Near Lough Foyle.

No. V.

CULTIVATION.

THE object of this report is not to give a detailed statement of the agriculture of the country, but simply to record the more general information which necessarily follows the inquiries of the geologist. The tables of cultivation have been framed to embody this information in a simple form, and though only co-extensive with the County of Derry, may be taken as a type of the agricultural arrangements of the counties of Tyrone and Fermanagh. The subdivision of the land, both as regards the farms and the fields, has so marked an influence on the appearance of the country, that it forces itself on the attention of the inquirer: in some parts of the Netherlands and of France, it has led to spade husbandry or to garden culture, to fences crowned with fruit trees, to the love and cultivation of flowers, and the result has been a refined, cleanly, and profitable system of agriculture: in Ireland, it has as yet produced few of these effects; the houses, though improving, are still too often rough externally, and internally deficient in comfort and cleanliness; the fences are wastefully large, and seldom applied to any profitable use; the fields are irregular in form, and often scattered about; green vegetables are only beginning to be cultivated, and flowers are rare exceptions to the general neglect. Improvement, however, has commenced, and throughout this district numerous examples may be found of comfortable looking houses, and that not in the vicinity of leading roads only, but in wilder and less frequented tracts, as, for example, in Dungate and the upland portion of Lissan. The internal comfort has not kept pace with the external improvement, and the mud floor, the rude bedstead of half hewn timber, and the bed of straw covered with a coloured quilt, frequently disappoint the expectations which an improved exterior had excited, whilst in inferior dwellings the calf, the pig, and the poultry still enter unchecked, and claim to share with the children the warmth of a room common to all. The exterior of the cottage having, however, been improved, the interior also will ere long receive its share of improvement; nor is it possible for any one who has taken shelter in these humble dwellings, and experienced the warm and hospitable welcome which invariably greets him, to feel indifferent to so desirable a result. Improved culture, and specially the more general introduction of vegetable and flower gardening, would mainly conduce to such an object, and on that account it is desirable to investigate the size of farms, and the system of culture adopted on them.

In Derry, (see tables) there are 1242 farms above 50 acres, or farms on which the most improved systems of farming on the large scale can be advantageously followed; with respect to them, it is unnecessary to say more, as they are in the hands of persons possessed of the means of managing them: 4145 are between 20 and 50 acres, of which 3013 do not exceed 35 acres, a sized farm which requires the active labour and co-operation of the farmer, but is still sufficiently large to admit a profitable employment of the ordinary system of tillage: below this size there are 6634 farms between 10 and 20 acres, and 10,449 under 10 acres, and in this great proportion the effort ought to be to lessen the number of horses, by the use of the spade, and to multiply the number of cows by the increase of green crops: such is, however, not the system of the country, and the same order and kind of crops are adopted on the farm of five acres as on that of thirty acres. Whether a farm be large or small, two horses are required to draw the plough effectually, and it is therefore necessary either to keep up an establishment for the small farm of eight acres sufficient to cultivate one of twenty acres, which is a great waste, or to do the work inefficiently, or to join with neighbours in forming a sufficient team. But there are other disadvantages in the small plough farms, which are usually overlooked, as, for instance, the great waste of ground in fences and headlands, amounting in some cases to nearly one acre in ten, and the waste of time in ploughing, consequent on frequent turnings. Sir John Sinclair (Systems of Husbandry, Vol. I., p. 228) has illustrated this subject by a comparative table, the first and last results of which may be quoted. The day's work being eight hours, and the furrow slice eight inches broad: field, 78 yards long; breadth, to give an acre, 62 yards; number of furrows in an acre, 279; time taken up in turning, four hours thirty-nine minutes; time taken up in stirring the soil, three hours twenty-one minutes: field, 274 yards long; breadth, to give an acre, seventeen and two-thirds yards; number of furrows in the acre, seventy-nine; time taken up in turning, one hour nineteen minutes; time taken up in stirring the soil, six hours forty-one minutes. "Thus it appears, when ridges are 78 yards in length, that no less a space of time than four hours and thirty-nine minutes is spent in turnings in a journey of eight hours; whereas, when ridges are 274 yards long, one hour and nineteen minutes is sufficient in the same length of time. What, then, must not the waste of time be in small paddocks?"

In endeavouring to ascertain the system of farming actually pursued by the small holders, much difficulty is always experienced from the imperfect knowledge they possess both of the acreage of their farms and of the meaning of a rotation of crops. Making, however, every allowance for the confused answers which are sometimes obtained to questions, Tables 2 and 3 are sufficient to show—

1st. That potatoes and oats are the staple crops.

2nd. That two and sometimes three grain crops succeed each other.

3rd. That the ground, exhausted by repeated crops, is left in grass for two or three years.

4th. That flax replaces one of the grain crops, or where little of it is sown, part of one; it is not allowed to ripen its seeds, and, being a comparatively short time in the ground, is considered by some of the farmers not so exhausting as grain crops; they do not, however, remember how little it returns of that which it takes away, even the immature seeds being lost or floated away in the steeping water. Turnips and clover have a place in other forms of cropping, but if the table of quantities be consulted, it will appear that they are comparatively minute, and quite insufficient to justify the opinion that the cultivation of turnips is general in the north: as yet, indeed, it has made slow progress, and in some places even retrograded, which is the case near Caledon, where some of the farmers, since the death of the late Earl of Caledon, have abandoned the culture of turnips, in the adoption of which they had been encouraged by that lamented nobleman. One of these farmers, an intelligent man, who raises a considerable quantity of onions, and cannot therefore be deemed a non-improver, explained the reason of the change, by stating "that the quantity of manure required for turnips would produce a good potato crop, and that potatoes were as good as turnips for the support of the cattle;" had he fully examined the question, he would have known that though in equal weights, potatoes exceed turnips in the amount of nutritive matter, the great weight of the turnip crop produces on the acre a larger aggregate of nutriment: the potato is best fitted for man, the turnip for beast. The principal cause of the slow progress of green crops, is the necessity of raising crops which are speedily convertible into money, in order to pay the rent. Every change of system requires time for its adaptation to circumstances. The grain crop is calculated upon as a regular and necessary resource, and if replaced by another, the money return of which is more distant, a temporary inconvenience is the result: to the rich farmer, the future gain would counterbalance the postponement of his returns, but to the small holder even a momentary relinquishment of his accustomed resources, is sometimes impossible. To induce, therefore, small farmers to restrict grain crops and adopt a matured system of green crops, it is necessary, not merely to explain the advantages of the change and to facilitate to every convert its adoption by having good seed at hand ready to be used, but also to give temporary accommodation by a well managed loan fund, or by postponing the payment of rent.

COUNTY OF LONDONDERRY.

1. SIZES OF FARMS.

Parishes.	Under 10 acres.	Between 10 and 20 acres.	Between 20 and 35 acres.	Between 20 and 50 acres.	Above 50 acres.	Total.
Aghadowey . . .	311	286	133	165	49	811
Aghanloo . . .	51	43	50	77	32	203
Agivey	63	31	11	14	2	110
Arboe	65	36	10	10	1	112
Artrea	955	321	95	111	12	1,399
Ballinderry . . .	162	69	25	30	1	262
Ballyaghran . . .	101	62	23	31	15	209
Ballymoney . . .	20	4	3	3	1	28
Ballynascreen . .	577	453	131	172	63	1,265
Ballyrashane . . .	35	35	38	52	15	137
Ballyscullion . . .	597	189	48	58	9	853
Ballywillin . . .	45	44	38	44	8	141
Balteagh . . .	56	101	98	140	49	346
Banagher . . .	284	247	107	149	42	722
Bovevagh . . .	148	234	140	201	45	628
Clondermot . . .	172	249	161	245	66	732
Coleraine . . .	118	58	53	72	13	261
Cumber, Lower . .	60	115	89	114	41	330
Cumber, Upper . .	228	268	146	195	69	760
Derryloran . . .	89	50	22	27	2	168
Desertlyn . . .	254	100	49	62	7	423
Desertmartin . .	401	198	70	73	5	677
Desertoghill . . .	191	244	117	139	27	601
Drumachose . . .	80	89	63	136	49	354
Dunboe . . .	84	148	98	154	62	448
Dungiven . . .	308	192	83	114	49	663
Errigal	166	241	140	179	72	658
Faughanvale . . .	126	180	128	165	62	533
Kilcronaghan . . .	256	148	53	68	13	485
Kildollagh . . .	42	28	20	30	3	103
Killelagh . . .	229	181	61	68	15	493
Killowen . . .	46	22	21	31	8	107
Kilrea	249	130	31	37	4	420
Lissan	335	204	67	92	19	650
Macosquin . . .	237	222	132	174	65	698
Maghera . . .	1,328	475	99	119	16	1,938
Magherafelt . . .	526	193	48	59	4	782
Magilligan . . .	58	88	57	75	69	290
Tamlaght . . .	110	41	25	31	4	186
Tamlaght Finlagan . .	182	152	123	176	76	586
Tamlaght O'Crilly . .	741	305	89	107	14	1,167
Templemore . . .	138	92	. .	126	61	417
Termoneeny . . .	225	66	18	20	3	314
Total, . .	10,449	6,634	3,013*	4,145	1,242	22,470

* Templemore not included.

2. ROTATIONS

Parishes.	Townlands.	Most Common in Townlands.								
		First Mode.								
		1	2	3	4	5	6	7	8	9
Aghadowey	Mullan	O	P	O F	O	G	G	.	.	.
Aghanloo	Ballyhanna	O	P	O	O	G	G	.	.	.
Agivey	Mullaghmore	O	P	O	O F	G	G	G	.	.
Arboe	Ballygonnymore	P	O F	O	G	G	.	.	.	.
Artrea	Ballymuldergmore	P	O F	.	.	.	.	.	.	.
Ballinderry	Ballydonnell	P	O F	O	G	G	.	.	.	.
Ballyaghran	Ballyleese, North	O	P	O	O	G	G	.	.	.
Ballymoney	Seacon, Lower	P	O C^s	G	G	G	.	.	.	.
Ballynascreen	Bancran Glebe	P	O	O	G	G	G	.	.	.
Ballyrashane	Articrunaght, South	O	P	B O	O F	G	G	G	.	.
Ballyscullion	Tamlaghtduff	P	O	P	O	P	O	G	G	G
Ballywillin	Islandmore, Lower	O	P	O	O C^s	C^c	G	.	.	.
Balteagh	Gortnarney	O	P	O F	O	G	G	.	.	.
Banagher	Carnanbane	P	O	O	G	G	G	.	.	.
Bovevagh	Drum	O	P	O	O F	O	G	G	.	.
Clondermot	Tullyally, Lower	P	O	F	W	O	G	G	.	.
Coleraine	Ballyclaber	O	P	O	O F	G	G	G	.	.
Cumber, Lower	Highmoor	P	O	F R	O	G	G	.	.	.
Cumber, Upper	Cumber	O	P F	O	O	G	G	G	.	.
Derryloran	Terressan	P	O F	O	G	G	.	.	.	.
Desertlyn	Larrycormick	P	O F	O	G	G	.	.	.	.
Desertmartin	Iniscarn	P	O F	O	G	G	.	.	.	.
Desertoghill	Moyletrakill	P	O	O F	P	O	O	G	G	.
Drumachose	Largyreagh	O	P	O	F	O	G	G	.	.
Dunboe	Sconce	P	O F	O	G	G	.	.	.	.
Dungiven	Carn	O	P	O F	O	G	G	.	.	.
Errigal	Liscall	P	O	O F	G	.	.	.	.	.
Faughanvale	Killylane	O	F	O	P	W	G	G	G	.
Kilcronaghan	Cloughfin	P	O F	O	G	G	.	.	.	.
Kildollagh	Damhead	O	P	O B F	O	G	G	G	.	.
Killelagh	Tirkane	P	O F	O	O	G	G	.	.	.
Killowen	Castletoodry	O	O	P	O B	O F	G	G	G	.
Kilrea	Moneygran	P	O	P	O	G	G	.	.	.
Lissan	Derryganard	P	O F	O	G	G	.	.	.	.
Macosquin	Ballywilliam	P	O	O	G	G	.	.	.	.
Maghera	Carew	P	O	O F	P	O	G	G	.	.
Magherafelt	Ballyheifer	P	O	.	.	.	.	.	.	.
Magilligan	Ballycarton	O	P	B	W	B^1	O	G	G	G
Tamlaght	Rusky, Lower	P	O F W	O	G	G	.	.	.	.
Tamlaght Finlagan	Clagan	P	O	O F	O	G	G	G	.	.
Tamlaght O'Crilly	Drumard	P	O	P	O	P	O	G	G	.
Templemore										
Termoneeny	Carricknakielt	P	O F	O	G	G	.		.	.

EXPLANATION OF TABLE.—B. Barley; B^1., Beans; C. Clover; c. cut; F. Flax; H. Hay; M. Mangold Wurzel; O. Oats; P. Potatoes; R. Rye; s. sown; T. Turnips; V. Vetches; W. Wheat. The numbers at the top denote the yearly succession of crops. For example, Townland

LONDONDERRY.

OF CROPS.

Introducing a greater variety of Crops.																
Second Mode.									Third Mode.							
1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8
O	P	O	O F	H	G	G	G	.	P	O	O F	P	O	H	G	.
O	P	O	V	O	G	G	.	.	.	.	.	.	.	.	.	.
O	P	O	O W F	H C	G	G	G	.	P	O	O F	G	G	G	.	.
P	W T R O	F H^s	O H	G	G	.	.	.	P	O C^s	C^c	G	.	.	.	.
P	R F H^s C^s	H^c C^c	.	.	.	.	.	.	P	O W	O F V	G	G	.	.	.
O	P	W O F	O C^s	C^c	G	G	.	.	P	O	O	.	.	.	.	.
O	P T M B	O H^s C^s	H^c C^c	G	.	.	.	.	O	F	P	B H^s	H^c	G	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P	O	O	P	O	G	G	.	.	O	P	O F	O	G	G	G	.
O	P	O C^s	C^c	G	G	.	.	.	P	O	P	O C^s H^s	G	G	.	.
P	O W	P	O H^s	H^c	G	.	.	.	P	O W	F C^s	C^c	G	G	G	G
O	P	B O	O H^s	H^c	G	G	.	.	O	P	B W	O F C^s	G	G	.	.
P	O	O F	O V	G	G	.	.	.	O	P	O B	F O V	O	G	G	.
O	P	O V	F B	O	G	G	G	.	O	P	O	O	G	G	.	.
O	P	O F	O	G	G	.	.	.	O	P T	O	F O V	G	G	G	.
O	O	T P	O F	O V	G	G	G	.	.	.	.	.	.	.	.	.
O	P	W B	H^c C^c	G	O B	H^c C^c	G	.	O	P	F	F	.	.	.	.
O	P	O R	F	O	H	G	G	.	.	.	.	.	.	.	.	.
O	O F	P T	O	G	G	G	G	G	O	P	O	O	G	G	.	.
O	P T	W O	H^c	G	.	.	.	.	P	O C^s	C^c	G	.	.	.	.
O	P T	O H^s	H^c	G	G	.	.	.	P	O	O F C^s	C^c	.	.	.	.
PT	O F	O	G	G	G	.	.	.	P	O F H^s C^s	H^c C^c	G	G	.	.	.
P	O	O	.	.	.	.	.	.	O	P	O F	O	G	G	G	G
O	O	P T	B	F	O	G	G	G	O	P	O	O	G	G	.	.
P	O	O	G	G	G	.	.	.	O	P	O	G	G	G	.	.
O	P	O	O F	O	G	G	.	.	P	F O	V O	O	G	G	.	.
P	O R	F	O	G	G	.	.	.	PT	O	O F	P	O H^s	H	G	G
O	P	W F	T V	O	G	G	.	.	P	B O	F	P	O	G	G	.
O	P T	O V	O F	G	G	.	.	.	P	O F	O H^s	H^c	G	G	.	.
O	P	O H^s C^s	H^c C^c	G	G	.	.	.	O	P	O	F H^s	G	G	.	.
P	O F	O	G	G	.	.	.	.	P	O F	O	O	G	G	G	.
O	O	P	O B C^s	C^c G	G	G	.	.	O	P	O B	O F	G	G	.	.
O	P T	O	O F V	O	G	G	.	.	P	O W	O F	P	O	H^c C^c	G	G
P	O F	O	P	O F C^s	C^c	G	G	.	P	O R	O H^s	G	G	.	.	.
O	P	O	O F	H	G	G	.	.	P	O	F	O	G	G	G	.
P	W B	O F	O C	G	G	.	.	.	P	O	O F	H	G	G	G	.
O	P T	W O V	O	G	G	.	.	.	P	O H^s C^s	H^c C^c	G	G	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
O	P	O	O V C^s	G	G	G	.	.	P	O F C^s	C^c	G	G	.	.	.
P	B O	F H	G	G	O	F	O	.	P	W B O	O F	H	G	G	O	.
P	O W	V	G	G	.	.	.	.	P	O	F	P	O C^s	C^c	.	.
P	O B R	O F	H	.	.	.	.	.	P	W O	O F	O	G	G	.	.

Ballyleese North, second mode, 1st year Oats; 2nd Potatoes, Turnips, Mangold Wurzel or Beans; 3rd, Oats with Hay and Clover sown; 4th, the Hay and Clover crop cut (generally more than once); 5th, Grass.

COUNTY OF

3. PROPORTIONS

Parishes.	Townlands.	Acres under					
		Pasture.	Meadow.	Roads.	Bog, Waste, and Mountain Pasture.	Plantations.	Tillage.
Aghadowey	Mullan	85·0	23·0	6·0	43·0	3·0	78·8
Aghanloo	Ballyhanna	15·0	.	8·0	369·0	.	41·3
Agivey	Mullaghmore	79·0	13·5	7·5	2·3	2·2	139·6
Arboe	Ballygonnymore	78·8	·4	3·0	6·7	3·2	121·3
Artrea	Ballymuldergmore	47·2	21·1	9·0	127·0	1·6	232·0
Ballinderry	Ballydonnell	104·3	21·5	7·0	17·4	2·8	273·6
Ballyaghran	Ballyleese, North	51·5	22·9	3·5	29·7	29·0	71·6
Ballymoney	Seacon, Lower	1·9	.	.	21·3	.	.
Ballynascreen	Bancran Glebe	76·5	24·3	20·0	424·0	.	206·0
Ballyrashane	Anticrunaght, South	64·5	1·9	4·0	13·1	1·2	71·9
Ballyscullion	Tamlaghtduff	92·7	17·0	20·0	301·2	·9	249·7
Ballywillin	Islandmore, Lower	32·0	10·0	2·5	2·0	·3	60·6
Balteagh	Gortnarney	55·5	2·4	9·0	396·0	.	99·3
Banagher	Carnanbane	111·9	5·2	14·3	1278·2	25·0	147·4
Bovevagh	Drum	357·0	6·8	29·0	1649·0	.	499·2
Clondermot	Tullyally, Lower	109·6	2·5	4·0	8·8	1·2	113·2
Coleraine	Ballyclaber	57·6	27·7	4·0	12·3	1·3	101·4
Cumber, Lower	Highmoor	82·6	7·7	7·0	433·5	·5	95·4
Cumber, Upper	Cumber	41·9	43·9	8·0	80·0	67·0	105·5
Derryloran	Terressan	54·1	4·4	4·0	10·4	2·8	113·8
Desertlyn	Larrycormick	100·4	26·7	10·6	58·3	1·8	204·9
Desertmartin	Iniscarn	111·5	5·7	11·0	412·3	29·2	151·2
Desertoghill	Moyletrakill	56·3	13·8	5·2	305·6	2·0	134·9
Drumachose	Largyreagh	30·4	·8	6·0	85·8	.	58·9
Dunboe	Sconce	233·0	8·4	6·0	136·0	.	75·6
Dungiven	Carn	90·0	28·4	17·0	1002·0	.	224·2
Errigal	Liscall	32·1	20·3	8·0	294·6	2·4	87·1
Faughanvale	Killylane	130·4	·8	14·3	129·0	.	233·7
Kilcronaghan	Cloughfin	57·5	6·0	5·0	28·5	.	83·8
Kildollagh	Damhead	105·9	19·4	7·0	8·1	.	124·6
Killelagh	Tirkane	67·1	62·3	17·0	862·5	15·5	234·6
Killowen	Castletoodry	77·8	2·6	7·0	24·0	.	83·4
Kilrea	Moneygran	125·6	25·1	9·0	318·9	9·3	260·1
Lissan	Derryganard	76·5	11·7	7·0	565·0	.	166·0
Macosquin	Ballywilliam	48·3	4·5	4·6	71·0	·6	90·9
Maghera	Carew	112·0	10·3	11·0	252·0	.	172·5
Magherafelt	Ballyheifer	68·9	39·7	5·4	53·7	4·0	148·7
Magilligan	Ballycarton	.	3·2	·7	71·6	4·5	51·0
Tamlaght	Rusky, Lower	36·2	21·1	2·5	.	4·4	82·0
Tamlaght Finlagan	Clagan	59·0	13·0	5·9	14·0	.	158·1
Tamlaght O'Crilly	Drumard	85·9	10·9	11·0	277·5	·4	278·8
Templemore							
Termoneeny	Carricknakielt	82·6	23·9	8·0	79·8	.	196·7

LONDONDERRY.

OF CROPS.

Acres under												
Wheat.	Barley.	Oats.	Rye.	Flax.	Potatoes.	Turnips.	Mangold Wurzel.	Beans.	Vetches.	Clover.	Forced Hay.	Natural Hay.
.	.	48·0	.	1·1	21·0	.	.	.	.	.	8·7	14·2
.	.	31·6	.	.	9·3	.	.	.	.	.	.	.
1·3	.	84·5	.	4·6	42·2	.	.	.	.	2·2	4·9	8·7
8·5	.	61·2	·4	9·5	38·7	1·8	.	.	.	·8	·4	.
15·8	.	106·5	1·0	7·0	94·6	.	.	.	·7	2·8	4·1	17·0
14·6	.	165·6	.	15·3	74·5	.	.	.	.	3·6	.	21·5
.	1·0	27·4	.	1·0	8·4	6·5	·3	·7	.	3·6	22·9	.
.	.	.	.	.	.	.	.	.		.	.	.
.	.	120·5	.	2·5	83·0	.	.	.	.	.	.	24·3
.	3·2	42·6	.	4·2	19·7	.	.	.	·5	1·8	.	1·9
24·3	.	101·3	.	4·7	114·2	.	.	.	.	·4	4·9	12·1
·3	5·2	31·6	.	·6	15·5	.	.	.	.	·3	7·1	·3
.	·8	69·7	.	2·8	24·6	.	.	.	1·4	.	.	2·4
.	1·3	91·4	.	13·6	40·6	·3	.	.	·2	.	.	5·2
.	.	360·5	.	27·1	110·7	·6	.	.	·3	.	.	6·8
.	.	70·6	.	13·7	25·5	1·8	.	.	1·6	.	.	2·5
6·4	1·0	48·7	.	6·3	21·6	.	.	.	.	3·6	14·2	13·5
.	.	55·5	.	7·1	24·5	·3	.	.	·3	.	7·7	.
.	.	72·9	.	7·4	22·6	2·6	.	.	.	.	.	43·9
1·2	.	69·2	.	2·8	34·8	1·2	.	.	.	1·2	3·2	1·2
4·4	.	107·7	.	6·5	70·1	·8	.	.	·8	6·1	8·5	18·2
.	.	90·7	.	4·3	52·2	·2	.	.	.	·9	2·8	2·8
.	.	81·0	.	7·7	46·2	.	.	.	.	.	.	13·8
.	4·1	38·9	.	2·6	13·0	·4	.	.	.	.	.	·8
.	.	52·6	.	·5	22·6	.	.	.	.	.	.	8 4
.	.	132·2	.	18·1	73·9	.	.	.	.	.	.	28·4
.	.	48·4	·2	3·7	30·3	1·3	.	.	.	.	3·2	17·1
14·2	·8	155·5	.	17·4	44·9	·4	.	.	·4	.	.	·8
.	.	47·0	.	8·1	24·7	·8	.	.	·4	.	2·8	3·2
.	2·9	78·4	.	6·3	35·8	.	.	.	.	·7	·6	18·7
.	.	139·6	.	9·2	85·8	.	.	.	.	.	.	62·3
.	9·3	49·7	.	·7	21·6	.	.	.	.	2·1	.	2·6
·4	.	127·6	1·6	18·9	104·5	1·8	.	.	1·6	3·2	·4	24·9
.	.	106·1	·4	3·6	54·7	.	.	.	.	1·2	.	11·7
.	.	64·8	.	3·2	21·0	.	.	.	.	.	1·9	2·6
4·5	1·6	86·3	.	16·5	61·2	.	.	.	.	1·9	·6	9·7
5·7	.	76·3	.	4·1	50·6	·8	.	.	·2	3·6	6·5	33·2
9·0	12·9	10·3	.	.	13·5	.	.	5·2	.	.	.	3·2
6·4	.	47·4	.	1·8	23·9	.	.	.	·4	1·2	.	21·1
1·3	5·2	83·8	.	25·5	29·3	.	.	.	.	.	13·0	.
1·6	.	128·8	.	21·3	112·7	·6	.	.	4·2	1·2	8·5	2·4
5·2	1·0	98·2	·6	13·9	77·2	.	.	.	.	.	1·0	22·9

COUNTY OF LONDONDERRY.

4. AVERAGE COST PER STATUTE ACRE.

Crop.	No. of Parishes from which the average is taken.	Processes included in Estimate of Cost.	Cost.		
			£	s.	d.
Wheat	27	(Ploughing and harrowing when practised,) sowing, (rolling, trenching, shovelling, and weeding, when practised,) reaping, threshing, and cleaning, . .	1	4	2
Barley	24	Ploughing, harrowing, sowing, (rolling, trenching, shovelling, and weeding, when practised,) reaping, threshing, and cleaning, ...	1	1	8
Oats	28	Ploughing, harrowing, sowing, (rolling, trenching, shovelling, and weeding, when practised,) reaping, threshing, and cleaning, ...	1	4	0
Rye	6	(Ploughing, when practised,) harrowing, sowing, (trenching, shovelling, and weeding, when practised,) reaping, threshing, and cleaning, . .	0	19	8
Flax	27	Ploughing, harrowing, sowing, (rolling, shovelling, and weeding, when practised,) pulling, watering, spreading, and lifting, ...	1	9	9
Potatoes in ridges	28	Ploughing, harrowing, spreading manure, dropping seed, setting, shovelling, (weeding and moulding, when practised,) digging, and gathering, . .	2	5	7
Potatoes in drills	17	Ploughing, harrowing, making drills, spreading manure, dropping seed, covering drills, moulding, (weeding and hoeing, when practised,) digging, and gathering, ...	2	8	11
Turnips	24	Ploughing, harrowing, opening drills, spreading manure, sowing, covering drills, hoeing, (weeding and thinning, when practised,) lifting, ...	2	3	7
Mangold Wurzel	8	Ploughing, harrowing, opening drills, spreading manure, sowing, closing drills, rolling, weeding, thinning, and raising, ...	2	3	6
Vetches	25	Ploughing, harrowing, sowing, (rolling, trenching, and shovelling, when practised,)	0	12	11
Beans	2	Ploughing, harrowing, sowing, trenching, shovelling, (weeding, when practised,) cutting, threshing, and cleaning, ...	1	8	0
Peas	10	Ploughing, harrowing, sowing, (trenching and shovelling, when practised,)	0	13	3

Drawing—of manure to the field, or of flax, oats, &c.—is not included in any of the estimates. Cutting of vetches or peas not included; these crops are in general cut green as they are used.

In some parts of the parish of Ballywillin, wheat is sown on the potato ridges before digging, and by raising the potatoes carefully with the spade, the wheat is covered, so that there is no ploughing or harrowing necessary; the farmers consider they have as good a crop as by the usual mode, if not a better; the cost of this mode of cultivation is 15*s.* 9*d.* per statute acre. In the parish of Lissan, the plough or harrow is seldom used for wheat; it is sown after the potatoes are raised, then trenched and shovelled.

Potatoes are moulded across the ridges in the parishes of Ballyaghran, Ballywillin, Coleraine, Ballyrashane, and Kildollagh, in addition to the usual operations; this costs, on an average, 4*s.* per acre.

Modes of Improvement.—Draining, an improved arrangement of crops, and an increased attention to horticulture, would quickly change the aspect of the country, spread over the now rugged and unadorned cottage an air of neatness and comfort, and supply new sources of enjoyment to its inmates. Such would undoubtedly be the results in the lower and richer parts of the country; but in the uplands or mountain districts, something more is necessary to produce a corresponding degree of improvement, and an increased effort should be made to replace by some more certain source of profitable industry the starvling crop of oats, which is more often cut green than ripe. In such districts sheep, in breed as high as the Cheviot, might be advantageously introduced, by allocating to each flock of 50 or 100 a proportionate tract of mountain land, and to the shepherd in charge of it a plot of arable ground at the base of the hill to raise turnips and a small quantity of grain, as food in bad or very cold weather. This person might be rendered responsible for his flock, and a regular cordon of agricultural police be thus formed of the shepherds to support each other in securing their respective charges from depredation. The Rev. W. Thorp (Agr. Journal, Vol. III., p. 431) states on the authority of Mr. Morton, that sheep kept warm in a shed consume each 20 lbs. of swede turnips daily, or a ton in 112 days, and one-fifth more when kept in the open field, or a ton in 93 days. Assuming the average quantity as a ton in 102 days, and allowing it to be necessary to provide such keep for four months or 120 days, six tons of swedes would be sufficient for five sheep, or sixty tons, the produce of three acres, for fifty sheep. It is to be observed that the numbers here stated represent *fattening* quantities, and might be much reduced where that is not the principal object. The mountains of the north of Derry and Tyrone are within a reasonable distance of the port of Derry, where the fattened sheep could be either sold for home consumption or shipped to Glasgow. In a system, such as that proposed, the dung of the sheep when fed at home would be a valuable acquisition to the farmer, and insure him a good potato and grain crop; and a moderate contract price for the feeding of the sheep would, therefore, be a sufficient remuneration for his care of them when in the field. On a four-shift rotation, the shepherd farms would each require twelve acres of arable land, and practical men will be able to judge, by calculation of profit and loss, whether it is possible or not to carry the system into effect. When wandering over the mountains or penetrating into the dales, it is impossible not to miss the flock, or at least to look with surprise on the few scattered sheep which here and there dot a surface of thousands of acres; and it is equally impossible to restrain the mind from devising schemes, whether wise or unwise, for remedying the evil of so great a waste of surface.

Sheep keeping, however, to be profitable, requires a considerable outlay in stock, sheds, &c., and can only, therefore, be undertaken by the great proprietors. The goat, on the contrary, is a hardy animal, and bears, in respect to the humble cottager, the same relation to the sheep as the ass does to the horse; it is, therefore, remarkable that so few goats should be kept, and their real value and uses so little known. In the mountain districts on the Continent the goat is better understood, and becomes, as well as the ewe, a valuable adjunct to the cow in cheese dairies. The cheese of Roquefort, a village of the Département de l'Aveyron, and about 2000 feet above the sea, is made of the milk of ewes, 100,000 of which are kept on the plain of Larzac, surrounding the village. The average quantity of cheese furnished by each ewe is about 18 lbs. The cheese of Mont-Cénis, in the Alps of Piedmont, is made of the mixed milk of cows, goats, and ewes. This manufacture extends from the plateau of Mont-Cénis, at an elevation of 1000 toizes above the sea, to Bessans and Bonneval, situated on the northern slope of the mountains. The usual proportions of the associated animals are four ewes to one cow, and one goat to ten ewes; a herd being sometimes composed of fifteen cows, sixty ewes, and six goats, and producing annually from fifty to fifty-five cheeses, each weighing about 26 lbs., or in all 12¼ cwt., besides 3 cwt. of butter, and a considerable quantity of "serai," a meagre or second cheese, made from the milk after the first cheese has been extracted, and used by the country people. The herd is only kept up during the season of pasturage, from the middle of June to September, when those which can be spared are sold at the fair of Suze, and the others are brought into stable with the first snow. The goats used in this manufacture are white, and without horns; their weight is nearly the same as that of a ewe, but they yield twice as much milk. The cheese of Mont d'Or is made from the milk of goats alone; the manufacture is of ancient origin, some of the pits used as reservoirs for fodder, principally the leaves of the vine, having apparently been constructed more than two hundred years. In the twelve "Communes" of the mountain there are 11,250 goats used for the manufacture. They are milked in summer three times a day, early in the morning, at noon, and late in the evening. The good milkers produce at each milking a pot of milk, each pot furnishes a cheese, worth on the spot four "sous" or 2*d.*, and at Lyon, 2½*d.* or 3*d.* These little cheeses are fit for salting in half an hour in summer, or in two hours in winter, are turned five or six times in the course of the day, and become firm in twenty-four hours in summer, or in three or four days in winter. They are sent to Lyon, packed between plates, ten or twelve days after being made, and are forwarded to various parts of France in boxes. They are much esteemed, and it is the opinion of M. Tessier, that mixing the milk of cows or ewes, which is sometimes surreptitiously done, injures the quality of the cheese. These examples are sufficient to show that the glens and southern slopes of the mountain districts, both of the north and south of Ireland, might become the seats of this branch of profitable industry.

Hitherto the manufacture of cheese in Ireland has had only a partial and very limited local success, nor can it be cited in any one district as forming a prominent feature in the farming operations. The failure in the attempts to make cheese has been ascribed to the climate and to the nature of the pastures, and it has been even said that with the assistance of English manipulators the attempt has failed; but it should be remembered that in every country where the manufacture has been attempted for the first time, the same difficulties have been experienced, and the same doubts of ultimate success expressed. M. Huzard (Art de Faire le Beurre, &c., p. 210) remarks, "It has been said that to make Parmesan cheese in any other country than Lodi, it would be necessary to transport thither the processes, the animals which supplied the milk, and the pastures on which they fed; and the same has been said in respect to the cheeses of Switzerland and of Holland: already, however, Swiss cheeses are made in many parts of Franche-Comté and of Dauphiné, and this manufacture has been introduced even in the south of France, as, for example, at La Grave, near Libourne, under the auspices of M. le Duc Decazes. Dutch cheeses are also extensively made at Varaville, in the département du Calvados, by MM. Scribe and Co., and specimens of this kind of cheese made at Isigny were exhibited by M. Dumarais, in 1819. It is not necessary, then, in order to make the cheese, to have the cows or the pastures of the countries where they were first manufactured; good milk is alone required."

This is an encouraging extract, and it may be hoped that perseverance will here, as in France, dispel difficulties, and ultimately establish the manufacture of good cheese.

Fruitières. Fromageries de Société.

Rural associations for the manufacture of cheese. There is, perhaps, no cause which operates so powerfully against the successful establishment of cheese dairies, as a deficient number of cows. On the Continent it is a received and well understood principle, that the cheese should be made without delay; for example, if a whole-cream cheese, such as the double Gloucester and Gruyères, after each milking, if a half-cream cheese, such as the single Gloucester, after the morning milking, so that the milk of the preceding evening may be first creamed and then mixed with the fresh morning milk; and even in cheeses like the Par-

Parmesan, where all the milk is creamed, it is essential that it should be made without delay, and the rule in the province of Lodi, which is the seat of the manufacture of Parmesan, is that the cheese should be made within twelve hours of the evening's milking. It is the same with Stilton and Neufchatel cheese, in which all the *cream* of the evening's milking is mixed with the fresh morning milk; and even with Cheshire, in which the cream of the evening's milk and one-third of the milk are retained and mixed with the morning's; the cheeses being made as soon as the early milking is over. M. Desmarets observes, that to manufacture successfully Gruyère cheese, it is necessary to command the milk of at least sixty cows, as there is little advantage in making cheeses of less weight than 56 lbs., but this being seldom possible, it is often necessary to mix the evening and morning milk together. In Cheshire, it is supposed that with twenty-five cows a cheese of 60 lbs. weight might be made daily, during the months of May, June, and July. In the province of Lodi, 200 "litres" or forty-four gallons of milk, are considered sufficient for each cheese kettle, or for a single Parmesan cheese, but twice that quantity or eighty-eight gallons is sometimes used, and the cheeses probably weigh from 20 to 40 lbs., M. Huzard premising that "there is no advantage, nor even a *hope of success* in making small cheeses.

The number of cows required to supply the proper quantity of milk will vary with the breed, and is widely different in different countries. M. D'Angeville estimates the annual produce in milk of his cows, which are of the small Jura breed, of the Département de l'Ain, the average living weight being 610 lbs., so low as 202 gallons; they are, however, used as working cattle, which lessens, in some degree, the produce. The large Swiss cow of Hofwyl, he estimates, on the average of a herd of fifty head, to produce annually 586 gallons; whilst Mr. Ayton estimates the produce of the Ayrshire breed so high as 1000 gallons. The milk of the cows of l'Ain is, however, richer than that of Ayrshire, in the proportion of 13 to 10, which corresponds with experience in respect to the Irish cows, and may, probably, be an advantage possessed by the milk of all hardy breeds.

If the annual produce of an Irish cow be assumed at 300 gallons, thirty cows would, on an average, be necessary to produce daily a cheese of 25 lbs., or, during the favorable feeding weather, about twenty; and it is easy, therefore, to judge how rarely the experiment could have been made in Ireland under favorable circumstances. This difficulty is not peculiar to Ireland; it has been felt and appreciated in Switzerland, and was long since remedied by the introduction of "Fromageries," or "rural associations for making cheese," which are here introduced to public notice as one of the most powerful means which could be adopted to improve the condition of the small farmer, and to encourage him in the culture of green crops, and in the house-feeding of his cattle. A complete description of these establishments by M. J. H. Mayne, Professeur a l'Ecole Royale Vétérinaire de Lyon, has been published (Memoires de la Société Royale et Centrale d'Agriculture, 1840, pp. 269-376) by the Agricultural Society of France, and is deserving of the special attention of Irish proprietors.

The birth place of associations for making cheese appears to have been the Gruyère country, where Scheuchzer (1702) found the manufacture of fat or whole-cream cheeses, "Caseos pingues, quibus caseosa et butyrosa lactis inest pars," in a flourishing condition, and described it with figures of the implements in his "Itinera Alpina," pp. 52-62. Scheuchzer states that Conrad Gesner had written on the same subject 150 years before, and observes that the Helvetic race, from this familiarity with the uses of milk, deserved the appellations of milk eaters and milk drinkers, which had been formerly bestowed on the "Nomades et Getæ," the more ancient inhabitants.

The system of association is conducted in two ways: in the most simple, the society engages a cheese-maker, who provides the necessary utensils, and shifts, day by day, from house to house, all the partners bringing their milk to the house of the associate, who is to have the cheese of that day. This is the mode adopted in the more ancient establishments formed at remote periods, when the chimneys of the Swiss cottages were built large enough to receive the cheese kettle and the crank by which it is suspended; and, notwithstanding the inconvenience of shifting the utensils daily and the trouble the manufacture occasions to the inmates of the farm kitchen, many proprietors cling to it, as they are thus enabled to watch the management of the milk, and to profit by the ashes of the wood used in its preparation. The cheeses, however, though made in private houses, are deposited in a common store, and carefully watched and tended by the cheeseman, a number and the name of the owner being attached to each. In the more perfect form of association, there is a distinct building with its appurtenances, belonging to the society, in which all the operations are conducted. This is called a "chalet," and where butter is also attended to, should be subdivided into five parts, namely, 1—The laboratory or fire-place room, where the milk is measured and the cheese and butter made. 2. The dairy, where the milk is deposited when intended to be creamed. 3. A store-room, if possible a cave, where the cheeses are kept and matured. 4. A small store-room for the salt, rennet, cloths, and implements not in use. 5. A lodging-room for the cheeseman. The chalet is either constructed by contributions from the associates, and repaired in a similar way, or built by a rich proprietor, and either hired or lent by him to his tenants; and, in some cases, they have been established by the public authorities. The business is conducted according to rules agreed upon and signed before a magistrate or notary by the associates. Those of a society, established (1828) in Lompnès, Département de l'Ain, may be thus abridged:—

Art. 1. The object is the fabrication of cheese de Gruyères.

2. The society shall exist, so long as 20 of its members continue to associate; ten days after the commencement of the season, whoever shall not have brought in his milk will be deemed to have quitted the society, and will forfeit his share in its property, which will be divided should the number fall below 20, amongst the still adhering associates.

3. A president and committee of four, elected every three years, will manage the society's affairs, and appoint, out of its members, a joint treasurer and secretary.

4. Supplies the place of the president, if absent, and provides for always maintaining the number of the committee at four, by calling in temporarily any of the other members.

5. Three of the committee may incur expenses amounting to 12*s.* 6*d.*, but five must be present to sanction a greater outlay.

6. Provides for the resignation or removal of the president and committee.

7. Secretary not to vote; to register proceedings.

8. The committee act gratuitously; the secretary is paid.

9. The committee decide all disputes.

10. The committee watch over the execution of the rules, and determine, without appeal, the fines to be paid for any infraction of them.

11. Associates guilty of negligence, or of fraud, may be fined.

12. Fines for negligence not to be less than 2*s.* 6*d.*, nor to exceed 41*s.* 8*d.*

13. Fines for fraud not to be less than 16*s.* 8*d.*, nor more than 83*s.* 4*d.*, except in the case provided for in the next article.

14. As a fraudulent mixture of water with the milk at once robs the society, and injures the character of its manufacture; the fine will, in such a case, be equal to the value of all the cheese which the offender then has in the store-room; and he will, besides, be either suspended or expelled, forfeiting thereby his share in the common property.

15. Repeated offences may be punished as in the last article.

16. An offender who insults the committee to be expelled.

17. No appeal from the judgment of the committee to any law tribunal.

18. The decisions to be signed by the president, registered by the secretary, and publicly exhibited for eight days.

19. No legal action to be undertaken, except under the authority of the president, and by him in the name of the society.

20. The president may call a meeting of the whole or part of the committee, and direct the attendance of the secretary.

21, 22. The president may incur any necessary expense up to 25*s.*, beyond which it must be voted by the committee.

23. The committee may, at the commencement of the season, admit new associates, requiring their written adhesion to the rules.

24. The committee may, up to the 1st of August, sell, wholesale, the cheeses made in the year, reserving a sufficient quantity for the home use of each associate.

25. The committee engage the cheeseman.

26, 27. At the close of the season, the associates meet to hear the president's report on the state of the society, and to audit the accounts; and at this meeting, a new committee will be elected every third year.

28. Names the committee and secretary for the first year.

29. Society considered to be established for at least thirty years.

30. On the death of an associate, his heirs may take his place, or may withdraw, in which case, they have no claim on the property of the society.

31. The number of associates to be settled ten days after the commencement of the season.

32. An associate, retiring before the close of the season, without permission of the president, is subject to the penalty of article 12.

33. The associates relinquish all right of appeal to legal tribunals, and recognise the committee as the sole arbiters between them and the cheeseman.

34. The president regulates the time, morning and evening, of bringing in the milk.

35. The milk to be brought, before being strained, in clean vessels; and the milk of fresh calved cows not to be brought in till ten days after the calving.

36. No milk mixed with that of ewes or of goats to be received.

37. Each associate may keep the milk he requires for his home use, but is not allowed to make either butter or cheese at his own house.

38. If an associate does not bring in his milk before three days after the opening of the season, he is subject to a fine; this is to guard against any attempt to hold it back, as the first made are inferior to the following cheeses.

39. Fines for infraction of rules 34, 35, 36, 37, 40, 41.

40. 41. An associate not to bring in the milk of a person not belonging to the society, nor to borrow that of another associate, nor to mix water with it, nor to abstract the cream. He is subject to penalties for any of these offences.

42. The cheese of each day shall belong to the associate who brought

in the most milk on the preceding evening; or, in cases of equality, to the one who first joined; and the cheeseman shall announce in the morning who is to have the cheese.

43. No one can withdraw his cheese from the store without an order from the president.

44. Every associate, at the commencement of the season, shall notify to the president the number of his cows; and if he should sell or buy any, he must renew his notice.

45—48. On introducing a new cow, the associate must notify it within twenty-four hours, naming the seller and place whence it came; and in a similar manner, he must notify the loss of a cow, and the nature of its ailment or death.

46. Immediate notice to be given of the illness of any of the cows, that the president may inspect them, and decide on what should be done.

47. Fines for a breach of articles 44, 45, 46, the same as enjoined in article 12.

49. The president and two of the committee named by him, must make at least one general inspection of the cows during the season.

50. At no time can an associate refuse the committee admission to his cow-house.

51. At the annual general meeting new rules may be made, or the old modified, by the majority of the associates present.

Such, then, is the matured form of establishments, which have grown out of the rural associations of the Alps, where their value has been tested by time; and they have now spread from Switzerland into Franche-Comté. Wherever an association has been formed, its advantages have been great, and its effect on the condition and comfort of the people manifest and striking. M. Mayne remarks, "These associations have produced similar results in the villages near Lons-le-Saulnier and Poligny; wherever they have been established for a short time, the proprietors have rejoiced in having them." "The cheese club," said an old man of Ruvilly, "has made the country rich; since we have associated together to manufacture cheese, the village possesses twice as many cows as formerly; we raise abundance of clover and lucerne; we home-feed our cows, and experience has taught us that the food picked up by the cattle in the neighbourhood or in the woods, does not pay for the loss of time and of manure." "We have had our cheese clubs these twelve years," said the schoolmaster of Gournon, "and since that period our butter has improved, and sold readily at a higher price, the number of cows has increased, those farmers who before kept two or three having now seven or eight, and instead of fattening cattle, those only who are too far from the 'chalet' stick to that business. Artificial grasses are much cultivated, and the value of property has increased by one-fifth; the farmer who was unable to pay a rent of £33 could now afford to pay £50, and that regularly at the time of selling his cheese."

These important results explain the reason why several large proprietors have constructed "chalets" in the neighbourhood of their demesnes, and defrayed the charges required by the first establishment of a fromagerie. It is a safe and profitable mode of applying capital, and, without interest, the improved rent of the land would be a sufficient return for the outlay.

In the mountains, the effect of such associations has been equally decided: twenty years ago, there were only four cheese manufactories in the village of d'Arçon, on the road from Pontarlier to Morteau, now there are nine; then artificial grasses were unknown, now saintfoin is largely cultivated; the number of brood mares diminishes every day, that of cows increases; the value of the land has been trebled.

It is unnecessary to cite other examples, but the questions with which M. Mayne prefaces his elaborate report are as applicable to Ireland as to France. "In associating together for the manipulation of milk, would not our small farmers lessen the inconveniences resulting from an extreme subdivision of the land? Without augmenting the expenses of the dairy, might they not obtain a produce greater and of better quality? Might not the farmers of most of our 'communes' establish cheese clubs similar to those which exist in Franche-Comté?"

These questions, then, are here submitted to the consideration of the enlightened proprietors of the northern counties; and it may be reasonably said, that in no part of the kingdom are there proprietors more fitted to examine them in all their bearings. If here also, as in the preceding cases, the great London companies are more especially referred to, it is simply because, as public bodies, their funds are more immediately available to the purposes of improvement, and may reasonably be expected to produce more decided and extensive effects. The system proposed is this: to build cheese-houses and dairies, and to stock them with implements; to procure experienced cheese makers; to engage a sufficient number of small farmers to bring the milk, fresh from their cows, to the cheese-house, and either to pay them a stipulated price for it or to allow them an equivalent proportion of cheese, after deducting a sufficient quantity to pay their quota of the current expenses; to allow the whey or the second cheese made from it, "serai," to the associates, in proportion to the quantity and quality of their milk, for the use of their families.

Such a system would enable the small farmer to bring the milk of his cows to an immediate market; it would furnish him with a new motive for increasing the number of his cows and cultivating the crops best fitted for feeding them; it would lead to home-feeding of cattle, an augmented quantity of improved manure, and a facility and inclination for spade or garden husbandry: by combining the efforts of many, it would do away with individual waste, and bring to perfection a valuable branch of agricultural industry. In mountain districts the same plan might be adopted, and associations formed for the supply and manufacture into cheese of the milk of cows, ewes, and goats, a further exercise of public spirit being here required in the introduction of the best breeds of the two last animals.

If, then, the system proposed be a wise one, can it be doubted that ere long the cheese-house and dairy will enter into the well matured plans of the Grocers' Company, will share with its schools the attention of the Fishmongers, and become new objects for gratifying the taste for refined improvement of the Drapers. Nor is it less probable that other great proprietors will be equally inclined to try an experiment in Ireland, which has produced such happy and beneficial results in other countries of very similar character.

Advantages of combining the efforts of the London companies.—In bringing together, in the preceding paragraph, the three leading companies, to which may be added the Mercers, whose improvements at Swatragh are already very perceptible, it may not be without advantage to consider very briefly the powerful influence which such wealthy and liberal bodies might exercise on the general improvement of the County of Derry, and, as an example, on the other northern counties, if their efforts were directed on a fully matured and combined plan.

The estates now in the hands of the companies cross the county diagonally from north-west to south-east, and are therefore within a convenient distance of every other part of the country. At present each company acts independently and without a knowledge of the proceedings of the others, and, as a natural consequence, the character of the improvements undertaken must vary with the peculiar taste of the several agents. In one, the expenditure of the company may be directed towards agriculture, as the proper foundation of every improvement; in another, towards schools; in a third, towards building and planting. Each system may be working its own object most successfully, and much may yet be unconsciously left undone. Nor can the deputations of the companies supply the deficiency, as in the short visits they are enabled to pay the estates, they only see the improvements of their own estates, and struck by their magnitude and importance, remain unconscious of their defects. If, however, the reports of improvements and of expenditure of each year, made by the agents, were submitted to a joint committee of the several companies, the merit of each particular system would be tested by comparison with that of others, and the question would arise, how far, in each case, the expenditure had produced the most beneficial results; building, planting, schools, and agricultural improvement would be contrasted together, and be ultimately combined in one matured plan. In a similar manner the agents should be required, either quarterly or half yearly, to assemble together and inspect each others estates; they would thus mutually support and instruct each other. These are only suggestions offered with diffidence to liberal and enlightened men.

Orchards.—The nearly total absence of fruit trees is a feature in the husbandry of this district almost as striking as the deficiency in vegetables. Throughout the County of Derry a fruit tree, beyond the boundaries of gentlemen's demesnes, is a rare spectacle; and in a considerable portion of the counties of Tyrone and Fermanagh, orchards are equally neglected. In the country bordering Lough Neagh they are sometimes met with; and about Loughgall, in Armagh, they are frequent, an abundant produce of apples being sent to the markets of Cookstown and other towns. If the soil of this tract of country be examined, it will be found to depend partly on the new red sandstone, partly on trap rocks, and partly on tertiary clays, modified by detritic sands. It is generally rich, and in great measure corresponds to the apple soils of Devonshire and Herefordshire. Wherever apple trees have been planted, they appear clean and healthy, yielding a good produce; and it may be said unhesitatingly, that the country from Moneymore, by Coagh to Mountjoy Castle, is peculiarly fitted to be an apple or cyder country. All that is required is the establishment by the proprietors of efficient cyder presses to insure to the grower a ready market for his apples; the selection and introduction of good varieties of apples; and a careful attention to the manufacture of the cyder. The same remarks may be made on other portions of Tyrone and Fermanagh, situated on earthy beds of the old red sandstone.

NOTE.—In the Systems of Husbandry, by Sir John Sinclair, (pages 54, 55, 56), a system of under-drains, invented by Mr. James Andrew, farmer at Tillylumb, is described and illustrated by a diagram. The drains were 18 feet apart, 2 feet 6 inches deep, filled to a depth of 1 foot with small stones, and covered with straw and earth. The advantages derived by Mr. Andrew are stated in terms as forcible as any now used, so that, in the year 1814, *a system of thorough draining was actually in operation in Scotland.* Sir John also states that, though new to Mr. Andrew, it was the common practice of Flanders, and had been introduced into Surrey by John Arbuthnot, Esq. of Mitcham. Mr. Pusey (Agr. Jour., Vol. III.), has likewise shown, in his interesting account of the progress of agricultural knowledge, that thorough draining had been tried, forty years ago, on two properties at Yoxford, in Suffolk, as also in Essex (where it was called the Essex system) very probably in consequence of the trials made in Surrey.

No. VI.

AGRICULTURAL SCHOOLS.

At a time when the most able Chemists and Physiologists are endeavouring to elucidate the principles of agriculture, the importance of imparting to practical men a knowledge which would enable them to co-operate in such researches is strongly felt, and hence the growing frequency of agricultural schools. Professor Daubeny (Agr. Jour. Vol. III., p. 364) gives a brief account of several establishments, both Continental and British, in which scientific and practical information on agriculture are combined; but in speaking of Ireland, he cites only the Model Farm of the Board of Education, and makes no mention of the only distinct agricultural school which, until recently, Ireland possessed. This omission will be here supplied by an account of the Templemoyle school, together with a brief notice of similar institutions either projected or formed anterior to the present increased knowledge of the subject.

Templemoyle Seminary.—Intimately connected with the interests of the country is an institution, the object of which is to spread the knowledge of agricultural science amongst those whose lives are destined to be passed in the labours of cultivating the land; inasmuch as it is now universally acknowledged, that although the first steps in this, as in every other practical art, have been made like those of the infant, by repeated trial and without reflection, yet to move forward in a steady and improving course towards more complex and productive results, requires that the mind should be called in to compare and weigh what has been done, and to establish, by a union of the results of experience with the anticipation of theory, a system equally removed from the first crude attempts of uneducated man and from the mere speculations of the unpractised theorist. The effectual mode of attaining this object, is by giving scientific instruction to the practical man, and thereby making him acquainted not merely with results, but with the causes which have led to them, as he is thus enabled to discover the probable means of diminishing or augmenting their influence. For this purpose, the Templemoyle school was founded; the system of the celebrated institution of M. Fellemberg, at Hofwyl, in the Canton of Berne, in Switzerland, having, as far as practicable, been followed in its establishment; but in order to render this the more palpable, and to estimate the past and present condition and future prospects of the Templemoyle school as a means of acting advantageously on the productive interests of the country, it will be desirable and instructive to give a preliminary sketch of the principles and arrangements of M. de Fellemberg's system, as also one of a more ancient, though abortive project, for effecting the same object; and finally to consider the Templemoyle school itself, under the heads of—

I.—Its Origin. II.—Pecuniary Incumbrances—Expenditure—Resources. III.—Physical Treatment—Diet—Lodging—Exercise. IV.—Instruction—Means and Mode of Discipline—How Enforced. V.—Pupils—Their Ages—Place of Birth—By whom Sent—Time of Continuance at School—Subsequent Distribution.

The project which will be first noticed, is that of M. L'Abbé Rozier, at once remarkable for its noble comprehensiveness, and for the singular fate which attended it. It was originally submitted to the French minister, Turgot, in the year 1775, and received by him with every mark of approbation; but before it could be carried into effect, the troubles of the time drove Turgot from his place, and, as a consequence, the infant design was stifled. In 1789 M. L'Abbé again brought forward his plan, but the "National Assembly" received it coldly, and although favorable replies to inquiries, addressed to them on the subject, were received from the Departmental authorities of Blois, nothing in aid of it was either done, or attempted to be done. In 1791, M. Rozier applied by letter to M. Le Comte François de Neufchateau, then deputy to the Legislative Assembly for the Department of the Vosges, and well known in France as an able scientific agriculturist, (since president of the Royal and Central Society of Agriculture in France,) requesting his aid in recovering from the public records, his "Plan d'une ecole nationale d'agriculture dans le parc de Chambord." In vain was every search made amongst the papers of the Committee of Agriculture, the document was missing, and it was only by chance that Le Comte de Neufchateau discovered that it had been carried into Spain, there translated into Spanish, and again restored to France as a translation from the Spanish. In the mean time L'Abbé Rozier perished, being killed by the explosion of a shell at the Siege of Lyons; but with ingenuous frankness Le Comte de Neufchateau did justice to his memory by setting forth the noble plan of the Abbé in all its details, and bestowing upon it the meed of admiration which its simplicity, grandeur, and comprehensive benevolence so fully merited. The place proposed for the establishment of a "National School of Agriculture," was the park and castle of Chambord, Department of the Loir and Cher. The position was selected as being central, and combining the requisites for every kind of cultivation pursued in France, excepting that of the olive. The extent, three leagues round, was very considerable; but not more than one-fourth part had been cultivated, and that very indifferently. The soil, principally an alluvion of the Loir and Cher, was above mediocrity, and in parts very good. The land was subdivided into small farms, and the rents being received by the Governors of Chambord who expended nothing in repairs or improvements, wretchedness prevailed, and the royal park, instead of proving an advantage, was a burthen to the state. The park and castle were first established by Francis I., who enclosed the territories of several villages by walls ten feet high, and employed in building them of stone, in a country not possessing a single quarry, fifteen hundred men for thirty years. The object was to secure a place of retreat for the Court, in case of danger from foreign invasion; but as the limits of France were so much enlarged in the time of Louis XIV., that this place of refuge was no longer required, it was bestowed as a royal gift on the Maréchal de Saxe. New buildings were now erected for the accommodation of his various retainers, their retinue, and horses, and the whole district, both within and without the park, was given up to the chase, and soon wore all the appearance of desolation. Though the immediate action of such devastating causes had long ceased, want of care and of encouragement had left the traces of their effects uneffaced, and the district was still impoverished and unimproved, when it was proposed to apply it to so different an object, for which it afforded many advantages, the castle being of vast extent and the various out-buildings erected by the Maréchal de Saxe, equally extensive. The plan of M. de Rozier embraced the instruction of teachers, as well as that of pupils, a principle, now thoroughly understood and valued. The class of persons he proposed to train as teachers may be considered inconsistent with present feelings, but that in no way affected the general principle. They were young priests, who were to perform their several ministerial duties at the school, whilst they received instruction in chemistry, botany, and physiology of plants, both theoretical and practical as regards agriculture, and also in all the processes of farming, being previously instructed by the head of the establishment, and becoming in turn his assistants, as monitors or *aides-de-camp*, in superintending the field operations, and watching over the several brigades of younger students. It was proposed that there should be thirty such intended teachers sent from the Governments, ten being received the first, ten the second, and ten the third year, and so on, ten retiring and ten being renewed each year. They were to be supplied gratuitously with lodging, food, washing, fire, and candle, but were to furnish their own clothing. Such was the system respecting teachers, and notwithstanding the difficulties as to the selection of persons, which would now prevent its adoption even in France, there can be no doubt that the influence of parish clergymen of all persuasions would be immense in pushing forward agricultural and other improvements, were they themselves fully imbued with such important practical knowledge.

The pupils were to be supplied and supported by the Governments, (Commanderies) one being sent annually by each; hence, as there were thirty-two Governments, the number of pupils would have been thirty-two in the first year, sixty-four in the second, and ninety-six in the third, at which number it was to remain fixed, the pupils remaining only three years, and consequently the numbers being diminished and increased by the same quantity after that period. The cost of their support was estimated at fifty francs, or nearly two guineas each, which sum was to be supplied by the several Governments, who were expected to select their pupils from a district as extensive as possible.

The tuition was to be conducted in the following manner—all theoretical or general instruction to be given through the tutors—each pupil to be provided with a small plot of ground, and all the necessary implements for its culture—and in each of these experimental farms, the mode of culture followed in the district of the individual was to be pursued, the aggregate of small farms thus bringing into comparison the varied modes of cultivation of the whole kingdom; and finally the pupils were to be employed in successive brigades, each week, on the labours of the field, orchard, vineyard, vegetable garden, stables, forge, and charcoal manufacture, so that, after their three years schooling, they would return to their homes practically instructed in all the arts of their future mode of life. M. Rozier also suggested, that each pupil on leaving the school should be supplied with a ram, and two fine wooled sheep; a little adjunct circumstance which is merely noticed as affording a valuable hint on the effect which might be produced by pupils on returning home, in spreading the knowledge and application of any desirable branch of husbandry. In addition to the preceding heads of the system, which may be considered purely educational, M. Rozier wished to take advantage of the great extent of the park of Chambord, and by degrees to fill it with a colony of instructed tenants, holding the land immediately under the control of the school authorities. For this purpose he proposed that ten male and ten female foundlings, or (as he says to avoid the opprobrium of the term) *orphans* of the age of eight years, should be selected from the several hospitals or other establishments, and should remain in or attached to the school till they had attained their twentieth year. By this arrangement, after twelve years, there would have been one hundred such pupils, or preparatory tenants, on the establishment, and that number would have remained constant. These pupils were to be supported entirely at the expense of the school which, however, was to receive with each an entrance fee from the respective hospitals. On their marriage, which was to take place exactly at the termination of their schooling, and in the month of June, they were to receive (each couple) a farm of twenty arpents (twenty-four and a half acres) of cultivated land enclosed by a fruit-bearing hedge, having a cottage within it composed of two lower rooms and two sleeping chambers above them, together with a stable behind. The crop in the ground was to become the property of the young married people, and they were to receive from the school, as an outfit, a cow, one cock and ten hens, six sheep, a bed furnished, six shirts and six chemises, several small articles of furniture, and thirty francs in money; the stock and money being returned to the school by annual payments of one-third, and thus contributing towards the outfit of the next marrying batch, the marriages taking place, as well as the entrances, every third year. The mode of tuition of these orphan pupils deserves also a special notice. The males, from their eighth to their fifteenth year, were to be employed in spinning linen and hempen yarn, and in the labours of the field suited to their ages; from their fifteenth to their twentieth, part of each day in receiving instruction in the theory and attending to the practical details of agriculture, and part in weaving linen and coarse cloths; and further, during this period, the last of their course of instruction, they were to be occupied in preparing the ground and in building the house, which they would occupy on marriage: the girls were to learn to knit, sew, and weave, and to attend to all the duties of the dairy and kitchen, as well as to the rearing of silk-worms, thus becoming, on marriage, efficient aids to their husbands in all their domestic concerns.

Such then was the scheme of L'Abbé Rozier, in the year 1775, and whatever difficulties might have been expected in working out its details, it is impossible not to see in it all the marks of a noble and philosophic spirit; nor can it be read without advantage, as affording most valuable hints to those who, appreciating the importance of that instruction which confers new powers of productive perception on the cultivator of the soil, desire to give to the nation at large the benefit of such an institution.

The project of M. Rozier was revived by Le Comte François de Neufchateau in a somewhat modified form, so as to combine together, a new town, a port, an agricultural school, and an agricultural colony; for all which purposes, the castle and park of Chambord were amply sufficient, as, according to the Count, the castle comprised four hundred rooms with fire-places, and in the out-buildings stabling for twelve hundred horses; whilst the park extended over a space of more than twelve thousand English acres, half of which were wood. A detailed account of this new scheme was read by Le Comte de Neufchateau to Buonaparte, then first Consul, but the arts of war were at that time more congenial to the mind of that great man than those of peace; and though he listened with patience to all the details of the proposed system, when the strength of the castle of Chambord, its extensive accommodations, and the original intention of using it as a place of refuge for the Court, were referred to, he at once resolved that Chambord should remain "un poste militaire;" a decision which was accompanied by a hint from one of his aides-de-camp, that the Count would have had more chance of success, had he given a military aspect to his agricultural colony. The castle of Chambord was retained by Buonaparte as a military post, to meet a possible and temporary future contingency; but France lost the opportunity of being the first to establish a great national school for instruction in the most important of all human sciences and arts—that of primary production or agriculture.

Unsupported by the Government of France, and coldly received by its great military ruler, the scheme of the Abbé Rozier had sunk into oblivion, and it was reserved for a private individual, the citizen of a small state, not merely to devise a plan equally comprehensive and important, but also to carry that plan into successful operation. This individual was Emmanuel Fellemberg, a native of the Canton of Berne, in Switzerland.

For some years this practical philosopher had seen, with regret and alarm, the defective state of Swiss agriculture. In several places the system was to manure for wheat, to take two crops in succession, and then to leave the ground in natural pasture for four or five years; in others, on breaking up the natural meadow, oats commenced the rotation, being followed by two crops, in succession, of wheat manured—whilst in many other places, as in the Canton of Zeug, the pasture was extended to the twelfth or even the sixteenth year, thus—rye, fallow, wheat manured, oats, pasture to the twelfth year; or, as above stated, still longer; or according to this rotation, rye, oats, pasture till the twelfth year; systems which all displayed a total ignorance of scientific culture, and a lamentable mis-use of the productive resources of the country. The consideration of such systems will doubtless recall to the mind some of the ruder agriculture of Ireland, though, in fact, they were more defective, as not possessing the one ameliorating crop of Ireland, the potato crop.

Yet, notwithstanding this generally depreciated condition of Swiss agriculture, some gleams of improvement had already appeared, and in the Canton of Zurich, and other better cultivated districts, so great an advance had been made, as to exhibit the following system, capable of being used as a three, six, or nine years' shift rotation, viz.—first, wheat—second, rye manured—third, clover—fourth, wheat—fifth, rye—sixth, beans, or other cleaning crop, strongly manured—

seventh, wheat—eighth, rye—ninth, potatoes, beets, or other renovating crop. Hence there was some reason and encouragement to hope that the effects of good example would be successful in spreading a more refined system of agriculture in places still lower in the scale of improvement. Having, therefore, purchased the demesne of Hofwyl, M. Fellemberg proceeded to apply to its cultivation the principles of science. Draining and deep ploughing were both exhibited in their full extent, and by the advice of Tchiffeli, clover assumed an important part in the system, by which improvement, the money returns of the farm were at once doubled. The culture was, however, still very defective, three years of clover being followed by three years of grain crops, and although at first so promising, the consequences were a rapid deterioration of the land, and a diminution of profits. Abandoning, therefore, a system in which the clover and the grain crops co-operated towards exhaustion, M. Fellemberg adopted the following, (taking care to keep up the preliminary operations of draining and deep ploughing in their highest state of perfection) viz.—

1.—Cleaning crops, of various kinds, such as beans, &c., two crops being taken in the year.
2.—Spring grain, sown with clover, the first cutting of the clover constituting a second crop.
3.—Clover cut from four to six times, and watered after each cutting.
4.—Grain sown in the preceding autumn, and followed, as a second crop, by carrots or turnips.

The result of this system reduced to English measures and English money, is as follows:—

Labour—cost per acre for four years, - -	£11 4 5¾	
Tithe, or tenth, rent, and allowance for use of agricultural implements, - -	13 10 5¼	£24 14 11
And the total return for the same period, - - -		57 14 7½
Leaving a profit on the four years of - - - -		£32 19 8½

or per annum £8 4*s.* 11*d.*, which being diminished by the interest of capital, and the greater amount of rent and other charges incidental to the finance of other countries, would still leave a very large net profit, far, indeed, beyond the probable profit per acre on ordinary Irish farming. The actual gain due to the improved system, will, however, be better understood by a comparison between the results of various systems of Swiss agriculture; the attendant circumstances being the same in each, as follows:—

	£	*s.*	*d.*
Two crops of wheat manured, followed by five of pasture, net profit per annum, ...	1	1	10
Two crops of wheat, one of rye, and three of clover, net profit per annum (this return rapidly diminishing after a few years),	2	5	2¾
Wheat, rye, clover; wheat, rye, beans; wheat, rye, potatoes, net profit per annum, ...	2	18	8¼
SYSTEM OF HOFWYL.			
1.—Cleaning crops, two crops in the year. 2.—Spring grain, followed by one cut of clover. 3.—Clover, four to six cuttings. 4.—Autumn grain, followed by carrots or turnips, . .	8	4	11

Whilst M. Fellemberg was thus demonstrating the advantages, by showing in practice, the gains of a system, which embraced not merely a judicious course of cropping, but also the powerful auxiliaries of thorough-draining and deep ploughing, he was not slow to feel that example makes but a tedious progress in spreading improvement, when opposed by prejudices and that cautious dread of innovation or change to which the less informed of all classes of society pertinaceously cling; and, hence, he devised the plan of not only holding out an example, but of preparing agriculturists, by instruction, to follow it. Actuated by this principle, and stimulated by the high and noble thought of raising the moral and intellectual condition of the agricultural population by infusing into the minds of both high and low the purifying principle of sound knowledge, M. Fellemberg projected the institution of Hofwyl, early in the present century. The plan comprised separate instruction for the rich and for the poor: but as much caution was requisite in selecting a master for the poor children, the college for the rich was first carried into effect, M. Fellemberg receiving into his house, as companions to his sons, several children, for whom he provided masters in the various branches of study suited to their ages, so as to combine the advantages of public and private education. The number of pupils was, of course, limited, but so pleased was the Emperor Alexander of Russia by his inspection of the system and its results, that he induced M. Fellemberg so to extend his accommodation for the children of the rich, as to receive a greater number, including many of the sons of Russian noblemen. In consequence, a large mansion was built, contiguous to the house, and in 1820, the number of pupils of this class was 100, and the number of professors for their instruction 30, besides masters for music, drawing, and all other branches of a liberal and refined education. Whilst the rich were thus receiving an education suited to their station in life, and acquiring such a theoretical and practical knowledge of agriculture, as would enable them to render the productive resources of their estates available to the utmost extent, M. Fellemberg was preparing to raise up to their aid, a body of men fitted, by the cultivation of their minds, to comprehend and act upon the plans of their masters or employers, and, by practical instruction, to apply their own labour to the greatest advantage. The school for the poor commenced in 1810, when, in Vehrli, a young man of nineteen years of age, and son of Thomas Vehrli, schoolmaster of Eschihofen, in Thurgovia, M. Fellemberg found a person fitted by education, by the possession of a knowledge and tact in the management of the human character, by command of temper, and by that enthusiasm which can alone overcome difficulties, to aid him in snatching from ignorance, and often from depravity, the children of uninstructed peasants, and to form them into intellectual, moral, and useful beings. To test the temper of Vehrli, and to imbue his mind with feelings corresponding to his own, M. Fellemberg admitted him for some months to his own table, and by instruction and frequent conversation, prepared him for his new situation, acquiring, in so doing, ample proof of his integrity, uprightness, and zeal. But as he grew more deeply impressed with the sacredness and dignity of the beneficent task he was about to undertake, and sensible of the important effects which such an example might produce on the condition of the poor, it became difficult to restrain his zealous ardour ; and M. Fellemberg who had intended to select the children from the most distressed and deserving families in the neighbourhood, finding the parents at once incapable of estimating the value of such an advantage and indifferent as to its possession, resolved, in order to give Vehrli an immediate field of exertion, to adopt the scholars indiscriminately as chance might point them out. This was a hazardous experiment, but its dangers were lessened by the rule of admitting, as much as possible, only one scholar at a time, so that each new comer might be studied, watched, and brought within a proper moral restraint, before others were introduced to distract the attention of the master. The first pupils were, George Mattman, a child of eight years of age, son of a reduced peasant of Lucerne : Madorli, a native of Solerme, who had been trained as a mendicant, and taken up with his parents as a vagrant in Alsace ; John Ammon, a child belonging to the Canton of Berne, who having been deserted by his parents, was protected by a forest-keeper; Samuel Hunziger, a child who had run away from his mother, a poor woman near Basle : and when it is considered, that even with these unpromising elements, the work of moral and intellectual instruction proceeded with little impediment towards ultimate success, can there be a doubt of the possibility of training up to a high standard both of intellect and morality the far better elements of a rural population, such as exists in Ireland. In 1813, there were twenty-three children in the poor school, besides a native of Fribourg, twenty-eight years of age, sent by the director of the poor of that place, and a native of Berne, aged twenty-seven, sent by the Commune of Sumisvald, to qualify themselves for the management of schools on a similar plan ; the Commune of Sumisvald intending to unite a school of industry with their poor-house, or "Asylum for children, and for the aged, crippled, and destitute poor." In 1820, the number exceeded thirty. The instruction and discipline of the two branches of the institution of Hofwyl, are in some respects different, being so modified as to meet the varied conditions of the pupils. In the college for the rich, M. Fellemberg personally presides, dining with the children, and being also present at their supper ; and though he does not instruct them as one of the regular masters or professors, he frequently attends to witness their progress in the schools, and to forward it by conversation and advice, both in the house and in the field. He is thus considered by all, rather as a parent and friend than as a master. To the moral character, indeed, of his pupils, M. Fellemberg directs his principal and most assiduous care, and they are taught to feel, that uprightness of character is the quality which he most highly values. Discipline with him, therefore, ceases to be the coercion of authority, and uninfluenced by rewards and medals, those doubtful incentives to exertion, or by the dread of humiliating punishment, the children yield obedience to confidence, to affection, and to the superior ascendancy of truth ; their faults are recapitulated in their presence, they are heard freely and patiently in their defence, and they are reproved with gentleness. The course of instruction is ample, both in theory and practice : the languages, ancient and modern, beginning with Greek, are taught with such effect that children of ten or twelve are not unfrequently heard singing, in their sports, the hymns of the Odyssey ; and the knowledge of history, ancient and modern, keeps pace with that of the languages—sacred history not being overlooked. Geography, mathematics, chemistry, botany, and general natural history, all combine to render this course effective towards its great object, that of enabling the gentleman to maintain his elevated station by possessing a moral and refined education; and at the same time, by having himself a thorough knowledge of agriculture as a science, to direct rightly, and truly to estimate, the exertions of those living and labouring on his estates. In the school for the poor, Vehrli supplies the place of M. Fellemberg, as a resident superintendent.—He and the children inhabit two large rooms, one used for sleeping, the other for work and instruction, a separate building being used for meals, and an open shed built, in a neighbouring grove, for instruction in summer. The distribution of hours is as follows—in summer the children rise at five, in winter at six, and having washed and dressed themselves, and said their prayers, they receive instruction for half an hour, then breakfast, and work till half-past eleven. They next dine, and receive a sedentary lesson for an hour. From one till six they work, then have their supper, and amuse themselves with various sports till within half an hour of bedtime, which half hour is devoted to instruction, concluded by prayer—between eight and nine they are in bed. This arrangement of hours is of course somewhat modified according to season, the number devoted to sedentary instruction being two in summer and four in winter, the hours of working being correspondingly increased or diminished. It is manifest, therefore, that literary is, in this system, subsidiary to practical instruction, and becomes a relaxation from labour; but it must be remembered that instruction can be often given in the field, with even more effect than in the school-room, and that opportunities of calling mental observation and comparison and especially the exercise of mental arithmetic into play, are never wanting to the judicious instructor.

Hence, on this simple plan, the children have been taught reading, writing, drawing, singing, the elements of grammar and geometry, arithmetic, beginning with mental calculation, some knowledge of the daily phenomena and different productions of nature, and as much of geography and the history of their own country as is likely to prove useful; the practical application of what they learn being constantly inculcated, so that the ready estimation of distances, areas, forms, becomes familiar, as well as the knowledge of objects about them; the children learning to distinguish the plants valuable to agriculture from those condemned as weeds, to form herbals, to distinguish the stones found in the fields, and, in the case of Madorli (once a common beggar), to begin a catalogue of all the natural bodies of the neighbourhood, ranged under their proper heads. In the evening, the children read some interesting book, such as Pestalozzi's Leonard and Gertrude, or the Robinson Crusoe of Campe; one reading aloud, whilst Vehrli questions the listeners to ascertain that they thoroughly understand what they hear.

The manual labour, whether in the open air, or in the house, is suited to the various ages and strength of the children. In fine weather they hoe, weed, glean, transplant, gather beans, peas, &c.; drive the horses at plough, and other work; prepare manure, and assist in all the daily labours of the farm. In unfavorable weather, they make baskets, plait straw for chairs and mats, split or saw wood, make up faggots, thresh, riddle, cut up the roots for cattle, and knit stockings, the elder learning trades, such as that of a wheelwright, &c., and assist, by turns, in the workshops. Sunday is partly devoted to religious exercises and instruction, and partly to walking, as exercise and recreation. The meals are simple; breakfast, consisting of soup, vegetables, milk and bread; dinner and supper of the same, with potatoes, and on Sunday, meat. The bread is a mixture of wheat, barley, rye, and beans. The table is supplied from the kitchen of the farm-servants; but the pupils never eat with either the servants or work people, Vehrli presiding at and sharing in their meals.

The discipline so far differs from that of the higher school, that corporal chastisement is not prohibited: it is, however, very rarely required, and that only with the younger children, and is then never administered at the moment of the offence, but such a time after it as is sufficient to allow both master and child to be free from passion, or other influence; the nature of the fault being then explained and impressed on the mind of the culprit, and the necessity, for his own ultimate good, of checking him in its further commission.

Finally, the establishment of Hofwyl as a whole, comprises the following departments, all of which have a manifest co-operative connection in the great scheme of making agriculture the basis of national education:—

1. A farm, intended as a model.
2. An experimental farm.
3. A manufactory of agricultural implements.
4. A workshop employed in the improvement of agricultural mechanism.
5. A school of industry for the poor.
6. A seminary for children of the higher class.
7. An academy of theoretical and practical agriculture.

And, lastly, a school for the instruction of masters.

Reverting, now, to the school of Templemoyle, as the immediate object of investigation. It was founded in 1827, having been projected and established by the enlightened members of the North-west of Ireland Society, who had themselves felt the difficulty of introducing and extending improvement, whilst unaided by an instructed class of assistants. Taking the plan of M. Fellemberg as their guide, the original founders comprised in their design two branches, or schools: in one, everything necessary for the education of the gentleman would have been taught, and, of course, a considerable payment required from the pupils; in the other, such instruction only imparted as was required by and adapted to the condition and means of the great mass of the agricultural population: the two establishments so far co-operating to the one end, that, whilst the public lectures of the higher would have given to the agricultural pupils a sufficient amount of theory, the farm, partly worked by the pupils of the other, would have afforded to the more elevated students, a practical illustration of the theory they had learned. A short, but, unfortunately, an expensive trial convinced the subscribers that neither their funds nor existing circumstances would enable them to keep up both establishments, and they abandoned, therefore, the one intended for the rich, and devoted their whole attention and means to the more practical and industrial school for the poor. This was a wise decision, as the principal advantages of the higher branch of the establishment of Hofwyl, were manifestly beyond their reach. The place of M. Fellemberg it was impossible they should supply; he was himself a landed proprietor, possessed of a considerable estate, and gifted with a mind and education of the highest order. The principal recommendation, therefore, of Hofwyl to the rich, that the child of the noble or of the gentleman, entered into the family of one of his own grade, and was surrounded by all the refinements of his station, whilst he was stimulated to exertion by the example of one so exalted by talents and by virtues, must have been wanting. Professors of equal ability might readily have been found; but where was the gentleman of property who would have sacrificed his ease and devoted his time to the benevolent object of emulating a Fellemberg? The name, indeed, of Edgeworth may occur to the reader, but even in his more limited sphere of operation, what imitator has yet appeared?

The position of the site selected for the new seminary is, in every respect, favorable; being elevated about 180 feet above the sea, it is healthy and invigorating; whilst it commands a view of the rich and cultivated plain of Muff, its church and the other buildings of the village, of the wide expanse of Lough Foyle, of the mountains of Ennishowen, and of the precipitous range of Benyevenagh; the foreground of the landscape being heightened in beauty by the plantations of the Grocers' estate, which separate the Templemoyle farm from Foyle Park, and clothe with trees the steep sides of Muff Glen. Being distant from Muff one mile, from Londonderry six, from Newtownlimavady about eight, and from the mail-coach road between Belfast and Londonderry about a mile and a half, it has the further advantage of combining facility of access with a freedom from the calls of the idly curious. The house and offices were built at an expense of £2,400; one-half of which was contributed by the Grocers' Company, the landlords of the estate. They consist of a school-room, 40 feet long, 21½ wide, and 15 feet high; four dormitories, of which No. 1 is 40 feet long, 21½ wide, and 13 high; No. 2, 40 feet long, 21½ wide, and 13 high; No. 3, 35 feet long, 16 wide, and 13 high; No. 4, 23 feet long, 21½ wide, and 15 high. The whole containing 76 beds, each pupil having one to himself. A dining-room, 45 feet long, 15½ wide, and 15 high; and other rooms for the use of the committee, for the different masters, matrons, and servants, besides a kitchen, store-room, and other requisite offices; and as out-door buildings, two large rooms for pupils' boxes, a washing-room, dairy, stables, harness-room, tool-house, cow-house, piggeries, and barn. This statement shows that the accommodation afforded by the establishment is ample, embracing all that is necessary for the preservation of health and order; and it may be also observed, that, standing alone, and not as an adjunct to another establishment, it has required a great amount of expenditure, and is, in many respects, more comprehensive than the industrial school (taken alone) of Hofwyl. But there are yet some desiderata, which, it is to be hoped, may hereafter be supplied; such as the smiths' and other workshops, and the practical instruction, within the house, in useful arts, such as basket-making, &c., and it may, indeed, be here suggested, that the workshops of the Grocers' Company at Muff, might be rendered available to the school for these purposes, and a turn for mechanical invention amongst the scholars be by such means promoted and fostered.

The farm consists of 169 statute acres; has a north-easterly aspect, and rises gradually to the height of 313 feet. The soil is a thin retentive clay on a micaceous, gravelly-clay sub-soil; and as this is rather an unfavorable combination, the resources of furrow and other drains, are necessarily resorted to, as much as the funds of the institution will admit, affording a daily and most valuable lesson to the pupils; whilst, in like manner, the importance of watching the favorable periods for ploughing, sowing, and reaping, is brought home to the students' apprehension, by the nature of the soil, sub-soil, climate, and situation.

The systems of cropping adopted are the four and five shift rotations, 36 Cunningham or 45 statute acres being under the four shift, and 94 Cunningham or nearly 118 statute acres under the five shift course. The situation and division of the fields lead to a disparity in the number of acres under each rotation, and not a preference of the one to the other, as it was thought desirable that the pupils should see both in operation. The five shift rotation consists of, 1st year, oats after hay; 2nd, turnips, potatoes, vetches, beans, or flax, with manure; 3rd, wheat, barley, or oats, sown with clover and grasses; 4th, clover for soiling or hay; 5th, pasture. The four crop rotation is the same without the 5th or pasture year.

The extent of farm is sufficiently ample, and the system of culture is such as to afford full occupation to the scholars in field labour; whilst, as proof of the corresponding progress made in collateral studies, many of the senior pupils have, in their hours of recreation, surveyed and mapped the Templemoyle and adjacent farms. This fact leads to the observation, that the scholars of Templemoyle may be considered intermediate in station between those of the two seminaries of Hofwyl; not children of proprietors, as in the one, nor children of the destitute, as in the other; but calculated, from their origin, as children of honest and industrious farmers, and, from the education they receive, to act either as the managers or stewards of the landed proprietors, as improving farmers on their own account, or as masters in other schools of a still more industrial character. This has rendered it necessary to apply a larger proportion of time to scholastic training, than in the poor school of Hofwyl, the system becoming as well as the condition of the pupils, intermediate; and, in like manner, every effort is making to infuse such knowledge as is calculated to increase the agricultural capabilities, and to refine the taste of the Irish farmer. Hence, lectures on the horse, its treatment and use, have been given by an able veterinary surgeon; the culture of forest trees illustrated by the establishment of a nursery, and that of flowers and vegetables by great improvements in the garden: it may be added, that new facilities of instruction will be afforded to the pupils, as the pecuniary incumbrances diminish, and the available resources of the establishment proportionately increase. Botany has already been introduced but it will then be aided by regular lectures; agricultural chemistry is on the eve of introduction; and hereafter there can be no doubt that an experimental farm will be established as at Hofwyl, for the comparative trial of various systems of culture, and also that workshops will be set on foot for the manufacture of agricultural implements, in which the pupils may study, and try to improve, their forms and proportions. When these improvements have been effected, and minor industrial schools, in connection with Templemoyle as their general head, formed by the landed proprietors of the province, on their several estates, or even by Government in each parish, the system of Fellemberg will be in full and effective operation.

Finance.—In considering the financial condition and prospects of the Seminary, it is gratifying to record the liberality with which, in a district comparatively remote from the capital, and, therefore, depending on its own resources, a project so important to society, and yet so partially connected with individual interests, was hailed and carried into effect. The principal reliance was on subscriptions raised by shares of £25 each, 116 of which were subscribed for by the following individuals or companies:—

	SHARES.		SHARES.
Marquis of Abercorn,	4	James Henry, esq.,	1
Rev. Robert Alexander,	1	Henry B. Hunter, esq.,	1
Alexander Alexander, esq.,	2	Richard Hunter, esq.,	1
James Alexander, esq.,	1	John Johnston, esq.,	1
William H. Ash, esq.,	1	Rev. J. L. Knox,	1
Earl of Blessington,	4	Rev. William Knox,	1
Sir R. Bateson, bart., Belvoir,	2	Mrs. Kirwan, County Galway,	1
Sir R. Bateson, bart., Miltown,	1	George Lendrum, esq.,	1
Sir James Bruce, bart.,	2	Thomas Lindsay, esq.,	1
Sir John Burgoyne,	1	Acheson Lyle, esq.,	1
Rev. Edward Bowen,	1	Hugh Lyle, esq., Oaks,	1
Rev. Francis Brownlow,	1	Hugh Lyle, esq., Coleraine,	1
Barre Beresford esq.,	2	Rev. George Mansfield,	1
Stewart Bruce, esq.,	1	Rev. P. B. Maxwell,	1
Earl of Caledon,	4	Marcus M'Causland, esq.,	2
Commissioners of Woods and Forests	4	Carey M'Clelland, esq.,	1
Worshipful Drapers' Company,	4	William Miller, esq.,	1
Worshipful Grocers' Company,	4	Robert Ogilby, esq.,	2
Worshipful Fishmongers' Company,	4	Lord Bishop of Raphoe,	2
Worshipful Mercers' Company,	4	Rev. Thomas Richardson,	1
William L. Conyngham, esq.,	1	Thomas Ramsey, esq.,	1
Lord Bishop of Derry (Knox),	4	North-East Society,	3
Right Hon. George R. Dawson,	2	Sir Thomas Staples, bart.,	1
Rev. Charles Douglas,	1	Sir Charles Styles, bart.,	1
George Downes, esq.,	1	Arthur Sampson, esq.,	1
John Dysart, esq.,	1	Thomas Scott, esq.,	1
Sir R. A. Ferguson, bart.,	3	John Sinclair, esq.,	1
John Fenton, esq.,	1	John A. Smyth, esq.,	1
Andrew Ferguson, esq.,	1	Alexander R. Stewart, esq.,	2
Sir James Galbraith, bart.,	2	William Stewart, esq.,	2
Connolly Gage, esq.,	1	Marquis of Waterford,	2
Sir Samuel Hays, bart.,	2	Charles Warner, esq.,	2
General Hart,	1	Rev. John Young,	1
Rev. George Hays,	1	George Young, esq ,	1
John Hart, esq.,	1	Richard Young, esq.,	1

And in addition to the original subscribing shareholders, the Commissioners of Woods and Forests have since taken two more shares, and Mr. Herbert, of Mucruss, one.

In September, 1829, a further sum of £184 12*s.* was raised by subscriptions and annual contributions have been, at various subsequent periods, paid to the amount of more than £100. Considerable donations have, also, been made to the institution, namely,

From The Irish Peasantry Society,	£200	0	0
,, The Irish Society,	200	0	0
,, The Fishmongers' Company,	30	0	0
,, The North-Western Agricultural Society, in successive years,	705	0	0
,, The Grocers' Company, towards the house and offices,	1500	0	0

It may, therefore, be stated that, up to September, 1835, a capital of £5794 12*s.* had been dedicated to the buildings, and other purposes of the establishment, exclusive of the annual contributions and payments on behalf of the pupils; and, in September, 1838, the gross amount of money which had been raised from all classes of payments was £8,000. This sum would, doubtless, have left the establishment free from any kind of embarrassment, had not the attempted formation of a senior branch or college involved the managers in considerable and unprofitable expense. The growing improvement, however, of the property, the influence of prudent arrangements, and the increasing number of pupils, are all combining to extinguish debt, and to afford the means of improving the character and lessening the cost of education.

The accountant's report, dated September, 1835, is as follows:—

Amount of debts due treasurer, &c.,		£503 4 8
To meet the foregoing debt, there is now available for market,		
Wheat,	£130 0 0	
Barley,	8 0 0	
Bullocks,	150 0 0	
Flax,	50 0 0	
Making in all the sum of		£338 0 0
There is besides on the farm,—		
8 acres potatoes, at £8 per acre,	£64 0 0	
28 acres oats, at £4 per acre,	112 0 0	
Beans,	6 15 0	
5 horses,	40 0 0	
10 milch cows,	72 0 0	
16 head young cattle,	53 0 0	
7 swine,	11 10 0	
		£359 5 0
		£697 5 0

From which £503 4s. 8d., being deducted, leaves £194 0s. 4d., of immediately available property, above debts, independently of furniture and farming implements: and it may be added, that the surplus debt over the value of saleable produce alone, was only £165 4s. 8d.

This debt has been gradually diminishing; and during the year 1837, alone, £100 were applied towards its liquidation, as may be seen by the treasurer's detailed accounts, for the year 1838.

Account of Treasurer's Receipts and Disbursements, from August 31*st*, 1837, *to August* 31*st*, 1838.

House, &c.—Salaries and Servants' Wages:—		
Head master (annually),	£40 0 0	
Assistant master,	10 0 0	
Head farmer,	40 0 0	
Matron,	16 0 0	
Gardener,	22 0 0	
Servants,	17 0 0	
		£145 0 0
Provisions:—		
Groceries,	£30 15 2	
Beef,	70 17 4	

Bread,	£8 16 1	
Candles and soap,	10 0 0	
Meal,	35 0 0	
Potatoes,	13 0 0	
Fish,	1 2 0	
		£169 10 7
Repairs of Furniture :—		
Dunlap tins,	£2 15 6	
Mr. Gilmour, bed clothes,	1 15 7	
Beattie, Hardware,	6 0 0	
Carpet,	1 17 1½	
Carpenter,	3 0 0	
Clock,	0 10 0	
		£15 18 2½
Agricultural Seeds :—		
Pitt Skipton, esq., flax,	£12 12 0	
H. Walker,	20 0 0	
W. D. Smith, esq. and Hunter, seed wheat,	5 13 9	
Major Scott, oats and potatoes,	12 10 0	
Oats, Major Scott and Connolly Gage, esq.,	13 0 0	
Potatoes, £3 13*s*., and John Dysart, esq., flax,	13 13 0	
		£77 8 9
Manure :—		
Bones,	£19 10 0	
Limestone,	3 15 0	
		£23 5 0
Labour :—		
Labourers,	£45 8 0	
Threshing,	12 6 6	
Turf,	13 11 2	
Drains,	5 14 0	
Flax-dressing,	7 19 6	
Sweeping chimneys,	1 0 0	
Thatching,	1 3 0	
Horse work,	9 12 6	
Gardener,	8 6 8	
Mowing,	2 7 6	
Mason,	0 7 6	
Cooper,	0 12 0	
		£108 8 4
Repairs of Implements :—		
Blacksmith,	£20 13 0	
Carts,	7 10 0	
Spades,	3 12 6	
Plank,	1 2 2	
Mr. Cook, water-pipes,	0 14 9	
Saddler,	20 0 0	
		£53 12 5
Stock :—		
Horses,	£20 11 0	
Pigs,	4 5 0	
		£24 16 0

Incidental:—

Brooms,	£0	6	8			
Coals,	2	16	8			
Paint,	0	5	0			
Grazing cattle,	3	6	8			
Hay, straw, &c.,	8	7	9			
Medicine for horse,	0	3	6			
Rope,	0	12	0			
Service of brood mare,	1	9	0			
Tyrrell, lectures,	6	6	0			
Washing,	54	0	0			
Clothes for one boy (to be repaid),	1	6	0			
County cess,	11	6	8			
Discount on bill,	6	1	5			
Insurance,	2	14	9			
Postage and stamps,	0	10	8			
Printing receipts,	0	15	6	£100	8	3

Debt Paid:—

J. A. Smith (bill),	£60	0	0			
Pitt Skipton, esq.,	20	0	0			
M. Hempton,	20	0	0	£100	0	0
Total,				£818	7	6¼

Cr.

Receipts:—

Balance in Treasurer's hands, 31st August, 1837,	£45	11	8½			
Subscriptions,	81	4	0			
Pupils paid,	486	10	0			
Stock sold,	75	0	9			
Crop sold,	118	1	8			
Received for the use of a boy,	2	0	0			
Balance due treasurer,	9	19	5	£818	7	6¼

And, whilst the debt had been thus decreased, the property or stock of the establishment had increased, as shown by the annexed comparative return.

Abstract of Stock on Templemoyle Farm.

Kind.	Amount and value of Stock on hand, 1st Sept., 1837.				Amount and value of Stock on hand, 1st Sept., 1838.			
	Number	Value.			Number	Value.		
Horses,	6	£60	0	0	6	£56	11	0
Cows,	17	119	0	0	12	96	0	0
Two year old Cattle,	5	20	0	0	9	45	0	0
One year old ditto,	9	27	0	0	9	22	10	0
Calves,	9	12	0	0	5	7	10	0
Bulls,	2	12	0	0	2	20	0	0
Sheep,	11	15	2	6	9	12	0	0
Swine,	9	13	10	0	18	24	0	0
Draft Bullock,	–	–	–	–	1	10	0	0
		£278	12	6		£293	11	0

Reverting to the preceding statement of the receipts of 1838, and deducting from them the balance of 1837, and a sum received for the use of one of the pupils, it will be seen that they still exceeded, by more than forty pounds, the ordinary expenses; and, in respect to succeding years, as the number of pupils has been raised to 70, that sum will be very considerably augmented by the consequently increased payments. Hence, as the annual resources and the value of stock continue to increase, it is manifest that the financial aspect of the institution is full of hope and encouragement.

Physical Treatment.—The great object of all industrial schools should be, as in M. Fellemberg's, to elevate the intellectual and moral condition of the pupils, without incapacitating them for their ordinary occupations. They must be able to live on common things, until they have earned the means of possessing those of more difficult attainment; hence, frugal diet is an essential condition in such establishments, and the dietary of Templemoyle conforms fully to the rule.

DIETARY.

Breakfast.—Eleven ounces of oatmeal made in stirabout—one pint of sweet milk.

Dinner—Sunday.—Three quarters of a pound of beef, stewed with pepper and onions, or one half pound corned beef, with cabbage, and three and one half pounds of potatoes.

Monday.—One half pound of pickled pork, three and a half pounds of potatoes, one pint of buttermilk.

Tuesday.—Broth made of one half pound of beef, with leeks, cabbage, and parsley, and three and a half pounds of potatoes.

Wednesday.—Two ounces of butter, eight ounces of oatmeal made into bread, three and one half pounds of potatoes, and one pint of sweet milk.

Thursday.—Half a pound of pickled pork, with cabbage or turnips, and three and one half pounds of potatoes.

Friday.—Two ounces of butter, eight ounces of wheatmeal made into bread, one pint of sweet milk or fresh buttermilk, three and a half pounds potatoes.

Saturday.—Two ounces of butter, one pound of potatoes mashed, eight ounces of wheat meal made into bread, two and a half pounds of potatoes, one pint of buttermilk.

Supper.—In summer, flummery made of one pound oatmeal seeds, and one pint of sweet milk. In winter, three and a half pounds of potatoes, and one pint of buttermilk or sweet milk.

In lodging, the same system is strictly followed; the beds, bed-clothing, and all other necessary articles, being simple, though clean, and, therefore, within the reach of every industrious peasant. A proper degree of exercise is provided for by the distribution of hours, into field and home occupations, so that each pupil is in fine weather half the day in the open air, as explained by the following table:—

Work and School table, from the 20th March to the 23rd September.

Boys divided into two equal divisions, A. and B.

HOURS.		AT WORK.	AT SCHOOL.
5½	All rise.		
6 to 8,	- - - - -	A.	B.
8 to 9,	Breakfast.		
9 to 1.	- - - - -	A.	B.
1 to 2,	Dinner and play.		
2 to 6,	- - - - -	B.	A.
6 to 7,	Play.		
7 to 9,	Prepare lesson for next day.		
9,	To bed.		

On Tuesday B. commences with work in the morning, and A. with school and so on, shifting upon alternate days.

The arrangements for instruction are ample, and have proved efficient.

The in-door establishment consists of a head and second master, who instruct the pupils in spelling, reading, grammar, writing, arithmetic, geography, book-keeping, as applicable, both to agricultural and commercial accounts, Euclid's elements, algebra, trigonometry, with its application to heights and distances, and land-surveying, together with the use of the water-level, the theodolite, and chain.

The agricultural branch of the seminary is entrusted to a skilful and talented young man, a native of Scotland, who has under him a gardener and a ploughman.

Of the pupils, one-half are at their studies in the house, whilst the others are pursuing their agricultural instruction out of doors. This is the arrangement for the morning; in the afternoon, they so change, that the in-door and out-of-door education proceeds *pari passu*.

The garden, nursery, surveying and mapping, and occasional lectures, are all adjuncts to and complete the regular course of instruction.

The rules, by which this mixed system of instruction is kept in steady and uninterrupted progress, are simple, and arranged into two codes.

1ST, RULES FOR THE TEMPLEMOYLE SCHOOL.

1. The pupils are required to say their prayers in the morning, before leaving the dormitory, and at night before retiring to rest, each separately, and after the manner to which he has been habituated.

2. The pupils are required to wash their hands and faces before the commencement of business in the morning, on returning from agricultural labour, and after dinner.

3. The pupils are required to pay the strictest attention to their instructors, both during the hours of agricultural and literary occupations.

4. Strife, disobedience, inattention, or any other description of riotous or disorderly conduct, is punishable by extra labour or confinement, according to circumstances.

5. Diligent and respectful behaviour, continued for a considerable portion of time, will be rewarded by occasional permission, for the pupil so distinguished, to visit his home.

6. No pupil, on obtaining leave of absence, shall presume to continue it for a longer period than that prescribed to him on leaving the seminary.

7. During their rural labour, the pupils are to consider themselves amenable to the authority of their agricultural instructor alone; and, during their attendance in the school-room, to that of their literary instructor alone.

8. Non-attendance during any part of the time allotted either for literary or agricultural employment, will be punished as a serious offence.

9. During the hours of recreation, the pupils are to be under the superintendance of their instructors, and not suffered to pass beyond the limits of the play-ground, except under their guidance.

10. The pupils are required to keep those clothes not in immediate use neatly folded up in their trunks; and to be particular in never suffering any garment, book, implement, or other article belonging to or used by them, to lie about in a slovenly or disorderly manner.

11. Respect to superiors, and gentleness of demeanour, both among the pupils themselves, and towards the servants and labourers of the establishment, are particularly insisted upon, and will be considered a prominent ground of approbation and reward.

12. On Sundays the pupils are required to attend their respective places of worship, accompanied by their instructors or monitors; and it is earnestly recommended to them, to employ a part of the remainder of the day in reading the word of God, and in such other devotional exercises as their respective ministers may point out.

2ND, REGULATIONS, ETC.

1. As the great object is to make the boys practical farmers, one half of them will be at all times on the farm, where they will be employed in manual labour, and receive from the head farmer such instructions, reasons, and explanations as will render the mode of proceeding, in all the various operations performed on the farm, sufficiently intelligible to them. Every pupil is to be made a plough-man, and taught, not only how to use, but also how to settle the plough-irons for every soil and work; and to be instructed and made acquainted with the purpose and practical management of every other implement generally used. And all are to be kept closely to their work, either by the head farmer, or in his unavoidable absence, by the monitor placed by him in charge of them.

2. Their attention is to be drawn to stock of all kinds, and to the particular points which denote them to be good, bad, indifferent, hardy, delicate, good feeders, good milkers, &c., &c.

3. At the proper season of the year, the attention of the boys is to be directed to the making and repairing of fences, that they may know both how to make a new one, and what is of great advantage, how to repair and make permanent those of many years' standing.

4. The head farmer will deliver evening lectures to the pupils on the theory and practice of agriculture, explaining his reasons for adopting any particular crop, or rotation of crops, as well as the most suitable soil, and most approved mode of cultivation for each; the proper treatment and management of working, feeding, and dairy stock; the most approved breeds, and their adaptation to different situations and soils. He will point out the best method of reclaiming, draining, and improving land; and will direct attention to the most recent inventions in agricultural implements, detailing the respective merits of each.

5. After the boys have been taught to look at stock on a farm, with a farmer's eye, the committee propose that they should, in rotation, attend the head farmer to fairs and markets, in order to learn how to buy and sell stock. At the same time, the committee expect that the head farmer will make his visits to fairs as few as possible, as his attention to the pupils of the establishment is always required, and he should, therefore, be as seldom as possible absent from Templemoyle.

6. The labourers' book and dietary account are to be kept by the superintendent of the week, in the manner fixed on by the committee.

The stimulating, as well as the coercive means of enforcing the discipline embodied in the rules are—

1st. *Rewards or premiums.*—They are adopted in this, as in almost every school in Ireland, although totally opposed to the principles of M. Fellemberg, and indeed of sound philosophy, which in substance are, that the innate satisfaction derived from study, from regularity, and from cheerful obedience to necessary study, should constitute its own reward; and secondly, that the contention for prizes engenders more of a desire to conquer the individual than to secure excellence; intellectual supereminence sinking, from an object desirable on its own account, into the mere means of obtaining some other object. There can be no doubt that this very general system leads to the production of so many beginners in, and so few constant cultivators of learning. Yet, as the ages of the pupils of Templemoyle are very various, and include many so advanced in life, as already to have become habituated to the use of those artificial stimulants, it is probable that, until the means of the school will permit of some classification by ages, the system of premiums, however faulty, must be continued.

The premiums are awarded on annual examination, held before the Committee and subscribers, and conducted by examiners totally independent of the school. Messrs. Simpson, Philson, and Leatham, well known teachers of the city of Derry, and Mr. J. Anderson of Castlederg, officiated at the examination on September, 1838; and the premiums awarded were very numerous and liberal, under all the heads of instruction: namely, spelling, reading, grammar, geography, writing, mapping, arithmetic, book-keeping, mensuration, geometry, trigonometry, algebra, agriculture, and botany; and whatever may be the effect on the individual of such distinctive rewards, there can be but little doubt that they must spread a feeling of emulation amongst their relatives and neighbours, when carried home and exhibited by the successful competitors. The presence also on these occasions of most of the leading gentlemen of the country, as well as of ladies, has a tendency to raise the tone of the pupils' minds, and to impress upon them a sense of the importance of the science they have been theoretically and practically studying. Many of those gentlemen take a part in the examination, by either asking or suggesting questions, a practice which is deserving of recommendation, as calculated to give additional value and dignity to the examination.

2nd. The coercive means, or punishments, are wisely left in the hands of the visiting committee, and no corporal punishment is permitted; and, in both these particulars, the system of Templemoyle is an improvement on that of the industrial school of Hofwyl; the master having no power of punishing, the pupil never becoming the victim of caprice or hasty passion. The committee meet once every week, and decide on all complaints brought before them, hearing patiently all parties, and awarding simple punishments in proportion to the offences; such as the digging of an extra portion of drains, &c. Here, again, the philosopher would, doubtless, object to the principle of connecting in one idea labour and punishment; but, allowing for the necessary imperfections of all human institutions, the present deficiency of early training in society, and hence, the necessity of retaining in more matured institutions some of the modes of restraint to which the mind of the pupil has already become accustomed, it must be admitted, that there is much more to commend than to blame, in the Templemoyle discipline, whilst the transfer of all punishment from the master to a committee of cool and unprejudiced gentlemen, is a very great practical improvement: the small number of offences, and the trivial character of most of them, proving that it is not only speculatively but practically judicious.

Pupils.—To qualify a pupil for admission, a nomination was originally required from one of the £25 subscribers; but the right of nomination has been since extended by the committee to annual subscribers paying £2 for the first pupil, and £1 for each additional pupil.

The pupils at present in the institution have come from all parts of the country, and are of very various ages.

The state of the school at successive periods, and a general summary of its results up to August 1841, will be better shown in a tabular form, as follows:

Number of Pupils admitted to Seminary, up to August 20, 1841, and the Counties whence they came.

																								Eng.		Scotland.			
	Derry.	Tyrone.	Donegal.	Fermanagh.	Monaghan.	Armagh.	Antrim.	Down.	Louth.	Westmeath.	Kildare.	Dublin.	Queen's County.	Kilkenny.	Carlow.	Wexford.	Waterford.	Cork.	Kerry.	Limerick.	Galway.	Roscommon.	Leitrim.	Sligo.	Middlesex.	Lancashire.	Wigton.	Lanark.	Mid Lothian.	Total.
Admitted previous to Sept. 1838,	155	52	25	11	7	.	3	3	1	.	5	7	1	.	1	1	10	12	6	2	3	2	1	3	1	1	.	.	.	313
Admitted since Sept. 1838,	44	17	7	2	.	5	2	4	.	1	2	2	.	1	.	1	1	2	1	2	2	2	.	3	.	.	1	1	2	105
Total admitted previous to Aug. 20, 1841	199	69	32	13	7	5	5	7	1	1	7	9	1	1	1	2	11	14	7	4	5	4	1	6	1	1	1	1	2	418

Pupils in Templemoyle Seminary on 1st September in each year, and the Counties whence they came.

	Derry.	Tyrone.	Donegal.	Fermanagh.	Monaghan.	Antrim.	Down.	Dublin.	Kildare.	arlow.	Wexford.	Waterford.	Kilkenny.	Limerick.	Cork.	Kerry.	Galway.	Leitrim.	Roscommon.	Sligo.	Armagh.	Westmeath.	Lancashire.	Middlesex.	Total.
1835	11	11	1	.	2	.	.	2	.	.	1	1	.	.	4	.	.	.	.	.	.	.	.	.	33
1836	26	15	4	.	2	1	.	1	.	.	.	1	.	.	7	2	1	.	.	.	.	.	.	.	60
1837	30	11	8	.	1	1	.	1	.	.	.	3	.	.	.	3	1	1	1	1	.	.	.	.	57
1838	25	10	2	2	2	.	1	3	2	1	.	6	.	1	5	3	1	.	.	.	.	.	.	.	64
1839	31	7	1	2	1	.	2	1	1	.	1	3	1	2	5	2	2	.	.	.	2	.	1	.	65
1840	31	11	5	2	1	.	2	3	2	.	.	1	1	2	1	2	.	.	.	1	4	.	1	1	71
1841	31	15	5	3	.	2	2	.	2	.	.	.	.	2	.	.	.	.	2	2	2	1	1	1	68

The distribution of the pupils after the termination of their schooling, is deserving of particular attention, as affording evidence of the extent of its utility; and here there will be found a more varied application of their acquired knowledge than might have been anticipated; for, although the seminary was originally intended for the education of young men destined for agricultural pursuits, several individuals have availed themselves of the advantages derived from the course of instruction there pursued, to qualify themselves for other avocations; and of those who had already left the seminary, on September, 1838,

29 are employed as land stewards,
2 ———————— as assistant agents,
5 ———————— as schoolmasters,
1 ———————— as principal of an agricultural day-school,
8 ———————— as writing clerks,
6 ———————— as shopkeepers,
1 ———————— as civil engineer,
2 ———————— as assistants to county surveyors,

124 are employed at home in agricultural pursuits,
32 have emigrated to America, West Indies, and Australia;
39 left seminary since September, 1835, not having remained 12 months.
And 64 remained in seminary, on 1st September, 1838.

The committee state further that, in every instance, when young men have been sent from the seminary with the necessary certificates of qualification, they have been found to give entire satisfaction to those by whom they have been employed; and, when they are engaged in farming at home, they impart the knowledge which they had obtained at Templemoyle to their friends and neighbours.

The consideration of the extensive range of country which has supplied pupils to Templemoyle, fully justifies the Committee of Management in claiming for it the character of a national, rather than that of a local establishment, and evinces at once the wisdom and liberality of its founders and supporters. Looking at it in this light, a few observations will here be made on the propriety and mode of still further extending its sphere of utility.

1. Between the Seminary of Templemoyle and establishments of a minor and more purely industrial character, there exist very marked differences of design; the one in no respect interfering with the other, but each being fitted to co-operate with and perfect the efforts of the other.

2. The system of combining practical with scholastic education has been, for some years, gaining ground; and, in the first publication of the Central Society of Education, Mr. Duppa has described and advocated the cause of such industrial schools for the peasantry. He ably reasons that something more is necessary than literary instruction, and that the influence of training should not be confined to the precincts of the school, but be extended to the hours of relaxation and of play. Hence, even amusements are not beneath the teacher's attention; and in the hours of play, he should be found directing his pupils in the innocent indulgence of that natural buoyancy of spirits which characterizes childhood. An ascetic alone condemns the light-hearted song, or would restrain the village gambols: but other and more profitable modes of amusing the young may be found in the vegetable and flower-garden, the carpenter's and the turner's shops, which are almost sure to prove attractive to them. On this principle, in the schools established at Ealing in 1833, gardens of the sixteenth part of an acre were let at three halfpence per month to the elder boys, who go out in bands attended by monitors to cultivate them, labouring for three hours, partly for the institution, and partly for themselves, being paid for the work done for the institution. Having a rent to pay, their labour has at once a definite object; and, being instructed how to cultivate the ground, they soon learn to do so with profit. Their surplus crop they either sell or take home to their parents; and in the year preceding Mr. Duppa's Report, it is stated, that "there was not a boy who had not taken home, at least, two and three sacks of potatoes, besides other vegetables;" and "that one of the boys cleared £1 18*s*. 10*d*. from his sixteenth of an acre of land, after paying the rent, seeds, manure," &c. Detailed statements are given of several of the other gardens, and the profit of each exceeds one pound. It is evident that such a system must lead to an early knowledge of the value and right mode of applying time; and when to this is joined an improvement of taste by the cultivation of

flowers, which is one of the simplest and most philosophical modes of refining the human character, an excitation of ingenuity by the use of carpenter's and other tools, and a well-directed course of school instruction, there can be no doubt that, in the words of Mr. Duppa, "a sound foundation has been laid, habits acquired of industry and cheerfulness while at labour, of order and arrangement in the management of expenditure at home." It is unnecessary to follow Mr. Duppa in his description of the Rev. Mr. Rham's school, at Winkfield, near Windsor, and of several others, in all of which the principle is fully established, that by a joint system of in-door literary and out-door practical instruction, the child acquires quite as much book-knowledge as if, contrary to his natural impulse, he were confined for the whole time within the school; and in addition, the habit of finding pleasure in profitable industry.

3. To the children of cottagers attending a daily school, the training and instruction of such schools as those described in the preceding paragraph would be inestimable, and gradually introduce much comfort in the produce of the kitchen-garden and ornamental refinement in that of the flower-garden. They are establishments within the power of every extensive proprietor, and should, therefore, generally supersede the merely literary or book-learning school. It is to be hoped, that the London companies will endeavour to remodel their valuable and extensive schools on these principles, and that the Marquis of Waterford may, also, adopt a similar system; an example having already been set by Captain Kennedy at Loughash.

4. For the purpose of studying the more extended principles of agriculture, and following them out in all the details of draining and irrigation, preparing the ground by deep and other ploughing, manuring, cropping, &c., a more steady attendance than can always be commanded in day-schools is desirable, and it is here that an agricultural seminary, such as Templemoyle, becomes the proper and more efficient medium of instruction; and in addition, it affords the means of training up masters for the minor industrial schools, which should always be kept in connection with it. Such masters, having had the benefit of an extensive course of agricultural instruction, would be able to point the attention of the elder pupils to the defects of their parents' management, and thereby to use the young as instruments for improving the old.

5. Assuming the advantages to be, at least, equal to what has been stated, it may be asked, in what time they would be extensively felt by the country? and this admits of a ready answer. Templemoyle Seminary, in its present state, has sufficient accommodation for 72 pupils; hence, if the school be kept full, and one-third leave it each year (supposing the period of schooling fixed at three years), twenty-four pupils fully instructed would return to their homes, or to their intended employers each year, or 240 in ten years. Such a number spread over the whole island would afford a supply totally inadequate to the wants of the country; but, if the operations of the Templemoyle school were limited to a much less extended district; for instance, to one county, it would amount to 48 for each barony; or, if to two counties, to 24; a number sufficient to spread the influence of the system into every parish.

6. As the rights of existing shareholders to nominate from any part of the country could not, in justice, be limited, some further arrangements are necessary

to ensure the full extent of local advantage; such, for instance, as those which formed part of the plan of M. Rozier. Let, for example, the present school accommodation be applied as now to the reception of scholars, on the nomination of shareholders or subscribers; and let the counties of Derry and Tyrone present a sum capable of supplying, in new school and other rooms, sufficient accommodation for about 70 pupils, which sum might be considered equivalent to the purchase of the right of nomination: and further, let there be an annual presentment on behalf of these pupils, which, at the present rate of charge, would be £700; but, hereafter, would be much reduced.

7. On this principle, the above counties would be required to send twenty-four pupils each year to the school. That number would be divided amongst the baronies; and the proportion for each would be selected by the cess-payers, either at road sessions, or at a special sessions for the purpose.

8. The augmentation of pupils would require a similar augmentation of masters; and it may be here remarked, as well with respect to the present as to the projected arrangements, that at least one efficient master is necessary for every thirty pupils, and that with improving prospects, increased attention should be paid to the fitness of such masters, not merely to impart ordinary instruction, but to serve as the models of moral rectitude. The increased expense would be more than met by the increased subscriptions.

9. Before closing these remarks, it is right to observe that, taking the expenses of nine years, the cost of each boy to M. Fellemberg was about £3 8*s.* beyond the value of his work, and that this even was above the estimated cost on M. Rozier's system. The cost of Templemoyle is £10, and, therefore, nominally much beyond that of Hofwyl; but some allowance should be made for the difference of the two countries, and still more for the early difficulties of Templemoyle. It is, however, certain that the cost will hereafter be lowered, and the advantages of the school be thereby brought more within the reach of the farmer. To accelerate this desirable object, all the gentlemen who either wish to plant amongst their tenantry persons so instructed as to be able to contend against and overcome prejudice, and yet so known to their neighbours as to be able to improve without exciting suspicion; or to obtain for their own properties stewards, who, having lived amongst the people, and from infancy known their habits, will be best adapted to apply their labour to advantage without offending their prejudices or wounding their feelings, should step forward and give their pecuniary assistance, selecting and sending pupils of a proper age and promising dispositions, and should also afford to the institution, that equally valuable assistance—their personal attendance, whenever practicable, to watch over the institution, at once enhancing reward and enforcing punishment by the weight of their character and station.

Having acted on the committee of Templemoyle school, and attended the examinations, it would be wrong to omit mentioning that whilst it has many warm and active friends, none has more advanced its interests, by personal care and anxious zeal, than Sir Robert A. Ferguson, bart., M.P.

Horticultural Schools.—The schools referred to in the preceding paragraphs might be very appropriately designated horticultural schools; and when the deficiency of vegetables, flowers, and fruits, which characterizes the husbandry of Ireland, as stated under the head of cultivation, is considered, it is most desirable to enforce the importance of remedying it by adding to the ordinary tuition of schools some instruction in horticulture. A knowledge of agriculture can only be effectually acquired on, or in connection with a farm, but in teaching horticulture, only the moderate space of a garden is required, which could readily be supplied to many of the schools of large proprietors, and to most of those of the National Board, or, in the County of Derry, to all those of the London companies. In the schools of the Fishmongers' Company at Ballykelly a private class for learning fine needle-work has been introduced by the Misses M'Causland and Sampson, the materials being supplied and the work bought by the factories of Belfast and Scotland; and in a similar manner needle-work has been profitably introduced into the large school near Termon, under the auspices of the Rev. Mr. Beresford; but as yet nothing has been done to introduce horticulture, as a refining employment both for boys and girls. Every domestic manufacture is valuable as affording in-door employment; but a healthy, cheerful and elevating out-door employment, such as gardening, is not less so. The system of the Fishmongers' schools adopted in 1828, and finally modified in 1832, has been eminently successful in overcoming the difficulty of teaching children of various religious sects; but as yet it has advanced no further than the tuition of ordinary schools; how easy it would be to superadd to that instruction this one requisite, and how delightful it would be to see a garden, cultivated by the children, annexed to the buildings of the Ballykelly school.

The articles relating to the government of the Fishmongers' schools, referred to as so successful, are here extracted from a copy of the regulations, furnished, with the sanction of the company, by Arthur Sampson, their agent. They were adopted in 1828, and modified to their present form in 1832.

Of the Government of the Institution.

5th. The schools shall be under the superintendence of two separate boards of management; one for the northern division of the estate, situated in the parishes of Tamlaght Finlagan and Faughanvale, the other for the southern division, situated in the parishes of Banagher and Upper Cumber, including Loughermore.

6th. The agent of the company for the time being shall be a member of both boards.

7th. The clergymen of all religious persuasions, connected with the estate, may be members of the boards within their respective divisions.

8th. In addition to these, there shall be six members in each board, resident tenants in their respective divisions, and any vacancy by death, resignation, change of residence, or otherwise, shall be filled up from time to time by ballot, by the remaining members of the board.

9th. Each board shall meet in the beginning of every quarter (or oftener if it shall be deemed necessary) to examine and inquire into the progress of the scholars; to ascertain the amount due to the master or mistress of each school for the last quarter; to give orders to the agent in writing, signed by the chairman, for that or any other payment to be made, or any other necessary article to be procured, and for general business; and also to depute six of their members, two for each month of the current quarter, for the more immediate superintendence of the schools in the division.

10th. A special meeting shall be summoned by the company's agent, whenever he shall think it expedient, or whenever he shall be required so to do by three members in writing.

11th. Each board shall annually in the month of May elect, by ballot, a chairman and secretary, and it shall be the duty of the secretaries to attend all meetings of their respective boards, and make regular minutes of their proceedings in books to be kept for that purpose, and to furnish annually to the company, through their agent, a particular report of each school within their respective divisions, which report must be first approved of by the board, and signed by the chairman.

Expenditure of the Worshipful Company of Drapers on the Estate of Drapers, from the year 1818.

MONEYMORE.

	£	s.	d.
Instruction :—			
Building church	6000	0	0
„ First Presbyterian meeting-house	4000	0	0
„ Second ditto (part)	350	0	0
„ Roman Catholic chapel (part)	230	0	0
„ Schools and masters' and mistress' houses	800	0	0
„ Infant school and mistress' house	600	0	0
Police :—			
Building police barrack	360	0	0
Management :—			
Building agent's house	2200	0	0
„ Forester's house	520	0	0
Commercial :—			
Building market-house, hotel, dispensary, and surgeon's house	4500	0	0
„ Corn store and market-place, and four houses in High-street for shops	6000	0	0
„ Public barn	624	0	0
Miscellaneous :—			
Building houses (various)	15562	0	0

DRAPERSTOWN.

	£	s.	d.
Instruction :—			
Building spire to old church, with other improvements	300	0	0

	£	s.	d.
Commercial :—			
Building hotel, market-house, (dispensary, and surgeon's house included) - - - -	3990	0	0
„ Corn store and sheds - - - -	1550	0	0
Miscellaneous :—			
Cutting down hill in centre of town, making sewers, erecting pump, &c. - - - - -	1500	0	0
Building smithy and dwelling house - - -	340	0	0
„ Dwelling houses (eight cottages) - -	1150	0	0

Estate of Drapers—General.

	£	s.	d.
Instruction :—			
Subscription to new church, Ballynascreen - -	100	0	0
Ditto to various houses of worship in different parts of the country - - - - - -	1000	0	0
Building school-houses and masters' and mistresses' houses in Brackaghslievegallion and Ballynascreen divisions - - - - - -	2000	0	0
Commercial :—			
Building bridges and making roads through manor of Drapers, besides large sums expended in banking rivers, &c. - - - - - -	6000	0	0
Building flax mill, Annahavil - - - -	600	0	0
Miscellaneous :—			
Loans and donations to tenants to build houses - -	4880	0	0
Planting, about - - - - - -	9000	0	0
	£74156	0	0

In the preceding pages statements have been given of the amount and objects of a large portion of the expenditure of the Grocers' and Fishmongers' companies. The above statement of the expenditure of the Drapers' Company since the year 1818 has been lately supplied, with the authority of the company, by their agent, Rowley Miller, Esq. In the period of twenty-four years, a sum of £74,000 has been expended by the company in improvements, or rather more than £3000 per annum.

The mode in which this sum has been distributed, and the class of improvements to which it has been applied, will be at once seen in the preceding statement, as the items, which are generally given in round numbers, are arranged in respect both to localities and districts.

This statement adds new and strong support to the views which have been advanced of the great importance of regulating the efforts of bodies, so liberal in their expenditure, in some matured plan fitted to combine the three objects—social improvement, by moral, practical, and intellectual instruction—an increase of productive power, by the improvement of agriculture—improvement of the aspect of the country, by building and planting.

APPENDIX.

ADDENDA TO CHAPTER VI.

No. 1. TERTIARY DEPOSITS.—In Chapter VI., a brief sketch has, for the first time, been given of the tertiary calcareous clays which occur in the interior of the ancient northern bay of the County of Derry, at elevations from 100 to 450 feet above the sea. Those clays were stated to be distinguished from the superficial detritus of gravelly clay by a striking difference of colour which often marks, by a well defined line, the separation between them: by a difference of mineral composition; by containing numerous pebbles of chalk, flint, and basalt; and by marine shells. The perfect preservation of the characteristic shell Nucula *oblonga*, as compared with the broken condition of the much stronger Cyprina *Islandica*, was also adduced as evidence that the bank containing the shells was the actual habitation of the Nucula, though the fragments of the Cyprina had been washed in from a distance. Finally, it was argued that the peculiar position of these beds within a bay-like expansion, and the abundance of fragments of chalk, flint, and basalt, rendered it extremely probable that their deposition and the gradual sea wear of the chalk and basaltic cliffs were contemporaneous events.*

The actual substratum on which the tertiary beds rest in the County of Derry, must, judging from their position, vary from the mica schist to the new red sandstone. Their geological position was assumed to be the newer pleiocene, from their exact agreement in the nature of the clay and the abundance of Nucula *oblonga*, with that deposit in Scotland, as well as from the manifest distinction between them and the superficial detritus; it is, however, important and interesting to have these deposits brought into direct comparison with a similar one, which, whilst it occupies the same place in the bay of the Lagan as they do in the bay of the Foyle, was more exposed seaward, and therefore contains a greater amount of deep sea shells, and of species generally. For this valuable contribution the Report is indebted to James Bryce, Jun., Esq., and George C. Hyndman, Esq., of Belfast, two gentlemen well known for their scientific zeal, and who have thus brought into useful co-operation their respective attainments in geology and conchology.

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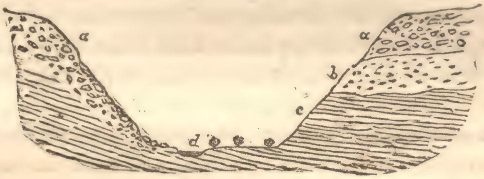
* It should be added, that Astarte *multicostata*? has been found *very rarely* in the Bovevagh Turritella bed.

Notice of an elevated deposit of marine shells, of the newer pleiocene epoch, lately discovered near Belfast, by James Bryce, Jun., Esq., A.M., F.G.S., and George C. Hyndman, Esq.

The reservoirs which are now constructing for the supply of water to Belfast are situated three quarters of a mile from the town, and close to the west side of the Antrim road. The cuttings were begun in the summer of 1841, and the authors paid constant attention to the sections which were from time to time exposed. To form the lower basin, the cuttings were extended in a northerly direction from the banks of the stream which is to supply the reservoirs, and presented a tolerably steep and continuous face to the south, through the whole length of the basin. After the fallen materials at the base of the steep bank of the river had been removed, a deposit of clay containing shells was exposed, resting upon the variegated marls, containing gypsum, which form the upper portion of the new red sandstone. The upper surface of the marl beds is slightly undulated, and to this the lower surface of the clay bed is of course conformed. It was covered by beds of loose sandy clay and the surface soil. These strata are shown in the section represented in the woodcut.

No. 26.



a, A sandy clay resting on. b, Shell bed. c, New red marls. d, River.

The deposit containing the shells varies from 8 to 10 feet in thickness, its surface is elevated 106 feet above the sill of the graving dock in Belfast, and its lower surface is about 12 or 15 feet above the level of the river. It occupies the whole north side of the lower basin; but as the southern bank of the stream was not cut down, the bed could not be there disclosed, nor was its upper surface reached by the cuttings in the upper basin. It consists, through its whole depth, of clay, extremely tough, compact, and difficult to work, and in colour varying from bluish-grey to bluish-red. The clay was unstratified, but beds and lumps of soft white sand and sandy clay, though of no great extent, occurred in several places. Rounded pieces of the following rocks were irregularly and very sparingly distributed through the clay:—granite, syenite, quartz, gneiss, mica slate, clay slate, greywacke, hornblende rock, porphyry, chalk, chalk flints, and greenstone, with fossils of the lias, greensand, and chalk, and very rarely pebbles of calcedony, and small corallines of the mountain limestone. The rocky fragments were all of small size, never weighing more than a pound or two, and generally much less. The smaller fragments are those of chalk and flint, which, with greenstone, are the more numerous; they have had, as also the fossils of the lias, greensand, and chalk, their origin in the adjoining hills. The fragments of the primary rocks are more rare, and to them a much more distant origin must be assigned; if they are really indigenous to this country, they must have come from the north-western parts of Donegal, as such rocks occur there in situ. To this, however, it may be objected that clay slate and greywacke are either entirely wanting in the travelled detritus of southern Antrim and the valley of the Lagan, or are extremely rare; whereas in this deposit they are, in comparison to the other primary pebbles, numerous. In fact, all the primary pebbles in the shell bed bear a much greater resemblance to those which are now found on the shores at the mouth of the bay, and which seem to be of Scottish origin, than to those of the superficial detritus in the interior of the country. In the gravel were found antlers of Cervus *Elephas* and teeth of the horse.

A list of the shells which were found is subjoined. They were scattered irregularly through the clay, and not arranged in continuous beds. Many were entire, but many also were worn, or in fragments. The superficial deposit covering the shell bed varies in thickness from 6 to 10 feet, and consists of loose earth, mixed with large boulders and small lumps of the common trap rocks of the neighbourhood, and with pebbles of quartz, chalk, and flint; but except the quartz, it was not found to contain any of the primary pebbles of the subjacent bed.

LIST OF SHELLS.

Rostellaria *pes pelicani*
Fusus *antiquus*
,, Ditto, var. *contrarius*, two worn specimens.
,, *corneus*.
,, *lamellosus* or *Peruvianus*, 1 specimen and 1 fragment.
,, *Bammfius*, rare.
Murex *erinaceus*.
Buccinum *undatum*, several specimens.
,, ,, elongated var. B. *fusiforme*, (Humphreys Zoo. Jour.) one specimen.
Nassa *reticulata*.
Purpura *lapillus*.
Turritella *terebra*.
Littorina *littoreus*.
Trochus *tumidus*, one fragment.
Natica *clausa*, rare.
Emarginula *fissura*, one specimen.
Ostrea *edulis*, fragments.
Pecten *maximus*, fragments.
Mytilus *edulis*, fragments.
Pectunculus *pilosus*, a few, and several fragments.
Arca *lactea*, 2 single valves.
Nucula *oblonga* (Brown)

Nucula *margaritacea*, fragments.
Cardium *echinatum*.
,, *edule*.
,, *nodosum*.
Tellina *solidula*.
Mactra *elliptica*.
,, *truncata*.
Cyprina *Islandica*, fragments only.
Venus *ovata*.
,, *gallina*.
Venus *decussata*.
Astarte *Damnonia*, a few.
,, *multicostata*, numerous.
,, *Scotica*, a few.
,, *Garensis*, numerous (not found living in Belfast bay at present.)
,, larger and smoother than A. *multicostata*.
Saxicava *rugosa*.
Serpula *vermicularis*, fragment.
Balanus, many pieces with a few valves.

The above list exhibits a mixture of littoral and deep water shells; and the clay and sand in which the shells were imbedded exactly resembles the recent estuary deposit at Belfast, lately exposed in the excavations for the new docks.

No. 2. Shell Marl.—As no deposit of shell marl of any magnitude occurs within the district, it was not intended to have specially referred to it on this occasion. The discovery of a small deposit of the kind near Dungannon having, however, been communicated by Robert Forster, Esq., it is here briefly noticed. It has been exposed in cutting a broad drain, and occurs at the bottom of a small hollow, or basin, on the east slope of Springfield Hill. It overlies alternating layers of gravel, sand, and clay, the immediate substratum being a reddish sand, and is overlaid by a layer of black vegetable matter, or "bog-stuff." At the edge of the drain, the marl is eight inches thick, and in the centre several feet, indicating a rapid augmentation in the depth of the pool containing it. Of shells, small bivalves are very rare, and the specimen sent was completely crushed. The univalves are abundant, all of one species—Limnæa *ovata* (Drap.) Helix *limosa* (Chemnitz.)*

No. 3. Slob.—It had been hoped to give a detailed account of the project for enclosing the slob of Lough Foyle, and of the manner in which the small portion done had been executed; but not having been able to procure such a statement from the directing persons, it can be only said, that, hitherto, the plans originally projected and contemplated at the time of passing the Act of Parliament have been very partially attempted. Of the embankment, to extend many miles and enclose many thousands of acres, a small portion only, executed by Mr. Dargan, has as yet been completed. The present bank extends three miles, and encloses 800 acres, the estimated expense having been about £3000 per mile; but Mr. Dargan has contracted to enclose a space of 2250 acres. No sluices have as yet been made, nor draining or other improvement attempted. The height of the embankment is about 12 feet, the slope 1 in 3, and in some places less, the face of the bank sinking so as to become slightly concave. It is faced with pebbles. It should be mentioned, that the contractor had to contend with some preliminary difficulties, such as that of procuring a quarry for stones; and after using a large portion of the celebrated Giant's Grave, near the Roe mouth, he even brought boulders, by water, from Donegal. The slob of Lough Foyle has hitherto yielded very few Infusoria or other microscopic objects, but that of Lough Swilly is rich in Foraminifera, which will be hereafter described.

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* There are several small deposits in Tyrone, two in Sheets 38, 39; one about 4 feet thick in the Lough 1 mile east from Ballygawley, and another to the south of it; one near Caledon, and another under a bog near Aughnacloy,—from the Caledon marl was obtained a splendid set of antlers of Cervus *Elephas*.

Addendum to Chapters V. and X.

The remarkable dyke or ridge of greenstone which crosses the new red sandstone country from Artrea to a point about two miles N. E. of Cookstown, has not been individually noticed. It is represented on the Map and Pl. F. fig 4. This narrow stripe of greenstone, though in some respects resembling a dyke, differs from it in other respects. It is considerably wider than is usual in dykes, is exhibited rather as a closely connected chain of rounded masses than as a continuous line of greenstone, and where penetrated sufficiently to show the internal structure, is composed of layers of varied character, similar to the constitution of the great basaltic flow. It is possibly analogous to such masses as those described in reference to Portrush, underlying, not overlying, the secondary strata, and similar also to the intruded mass at Coagh Bridge. Were it not for the varied character of its beds, it might have been considered a narrow stream of basaltic lava, of the greenstone type.

Addendum to Chapter VIII.

SIMPLE MINERALS.

Dr. Thomson having liberally contributed to this work the results of analyses of several Irish minerals, procured from the former collector for the survey, Mr. P. Doran, and examined in Dr. Thomson's laboratory; some of which he considers new, and the examinations during the season subsequently to the printing of Chapter VIII. having extended the range of several species, a few additional remarks are here subjoined.

Garnet.—The common variety, of little beauty, occurs in the talcose schists of the County of Tyrone.

BRONZITE?—Near the junction of the augitic greenstone, and the altered lias shales of Portrush, and in the rock which has been described as intermediate in character and probably metamorphic, a beautiful mineral occurs, which has the aspect of Bronzite. Its colour is a dark chestnut brown, assuming, on exposure, a bright copper tint. It forms very thin flakes, or laminæ which traverse the mass in all directions, and as the rock cleaves along them, it presents the appearance of pseudo-crystallization, though no regular form has been traced in the laminæ themselves. The pseudo-crystalline portion forms veins in the rock, and disseminated laminæ also occur, which frequently have the appearance of staurolite. The laminæ have none of the fibrous structure of the mineral which is ordinarily called Bronzite.

The results of Dr. Thomson's examination and analysis of a specimen of this mineral are—

Hardness, 5·5; sp. gr. 2·701; texture, foliated, opaque. Before blow-pipe, *per se*, becomes black; on charcoal, iron-grey, and assumes the metallic lustre; with soda fuses into a bead, red and transparent while in fusion, but white and opaque on cooling; with borax does not fuse.

Dr. Thomson's Analysis compared with one by Dr. Kane.

	By Dr. Thomson.	By Dr. Kane.
Silica	50·50	52·89
Alumina	23·00	19 29
Magnesia	0·00	2·19
Lime	16·00	5·39
Peroxide of Iron	5·85	17·82
Water	2·00	2·56
	97·35	100·14

Dr. Kane's analysis was obligingly undertaken for this Report, but as in neither case the laminæ of the mineral were separated from the mass in which they occur, if indeed they are distinct from it, the results cannot be depended upon. Dr. Thomson supposes it probable that his mineral contained an alkali, though from the minuteness of the specimen acted on, he was unable to detect it. Dr. Kane also analysed a specimen of the rocky matrix, and the close agreement of the result with that he had obtained from the supposed specimen of the mineral, indicates that if not the same, the matter of the matrix must have so predominated over that of the mineral as to mask the results. The agreement in the results of two analyses by Köhler, (Poggen. Annal.) the one of schiller spar and the other of its matrix, is of a similar character. The coincidence of Dr. Kane's analysis with that by Heyer of common or diatomous schiller spar, (Brochant, Tom. I., 422, Mohs. II., p. 207,) is remarkable, though the great excess 5·83 in Heyer's analysis renders it unsatisfactory; there is indeed much confusion in the whole of this class of minerals, schiller spar, diallage, &c. &c. The diallages analysed by Köhler and M. V. Regnault, are of a totally different type, alumina being present only in a small quantity, and the iron assumed to be a protoxide, the proportions of oxygen in the acid and base being as 2 to 1, or the same as in augite; M. Regnault observing that his analysis confirms the opinion of those who were inclined to refer the diallages to that mineral.—(Ann. de Chimie, Tom. LXIX., p. 66—71. 1838.) It was, with regret, found impossible to give a second analysis of the supposed Bronzite so freed from the matrix as to determine its true character, but the omission will be hereafter supplied by Dr. Kane. It is to be feared that should this mineral prove distinct, the adoption of the name Bronzite will add to the preexisting confusion.

Labradorite ?—To a mineral which has been hitherto referred to this species, Dr. Thomson gives the name of Silicite. It occurs in large crystalline lumps, or crystals, in a very dense close-grained basalt, or altered rock, near Island Magee, County Antrim.

Dr. Thomson's Description and Analysis.

"Structure, foliated; colour, white, with a shade of yellow; sp. gr. 2·666, hardness, nearly 7·0; lustre, vitreous. With carbonate of soda yields an opaque bead; with borax fuses into a transparent colourless bead.

Silica - - - -	54·80
Alumina - - - -	28·40
Protox. Iron - - - -	4·00
Lime - - - -	12·40
Water - - - -	0·64
	100·24

The formula is $7\ \mathrm{Al.\ S^2} + \mathrm{Cal.\ S.}$ It is a double anhydrous aluminous salt, admitting that the oxide of iron is combined with the alumina and only accidental."

There is a considerable difference in the proportions of their constituents in the specimens of Labradorite previously analyzed, (Thom. Min. Vol. I. 298,) but they all contain nearly 4 per cent. of soda; in actual mineral composition they differ, therefore, from the present species, but it is highly probable that the mean of several distinct analyses of this variety would give a very similar atomic constitution, as the result is principally affected by the excess of one atom of alumina in the present analysis.

Fluor Spar.—Found lining the cavities of organic remains (Productæ) in the carboniferous limestone, near Omagh. It occurs not unfrequently, in this manner, in the west of Ireland, but has not as yet been noticed in Derry. Colour, light purplish, violet blue.

Skolezite.—The nearly compact brick-red Zeolite from Port Stewart referred to this species, has been examined by Dr. Thomson. His result differs considerably from previous analyses of Skolezite, particularly in the defect of silica; but before the mineral can be allocated with certainty, some further inquiry seems necessary.

Dr. Thomson's Analysis—Sp. gr. 2·1654.

Silica - - - -	39·50
Alumina - - - -	25·15
Per. ox. Iron - - -	6·30
Lime - - - -	6·50
Magnesia - - - -	6·00
Water - - - -	15·10
	98·55

Levyne.—The beautiful bi-pyramidal crystals, which occur at Magilligan, &c., have been noticed under this head, with an expression of doubt, referring to the possibility of their identity with Phakolite, an opinion which was expressed in consequence of the striking coincidence of external form. In the proceedings of Roy. Soc. Edinburgh, of April, 1842, No. 20, p. 381, there is an accurate analysis of the Bohemian Phakolite by Dr. Anderson, the result of which corresponds to the formula, "$r\ S^3 + 2\ A\ S + 3\ A\ q$, the monatomic bases being lime, potash, and soda." The general formula for the group of Zeolites to which it belongs being "$r\ S^3 + x\ A\ S + z\ A\ q$, the equivalents of alumina and silica being variable as well as of water, r representing the variable monatomic bases."

At present there is no accurate analysis of the Irish mineral, but from its physical characters and a rough examination, there is every reason to believe that it is identical with the Bohemian Phakolite.

Laumonite.—A mineral, supposed from Down, has been alluded to under this head, and an opinion stated as to its composition. Dr. Thomson has analyzed a specimen obtained from Mr. Doran.

Dr. Thomson's Analysis—Sp. gr. 2·6785—hardness 2·5.

Silica - - - -	61·90
Alumina - - - -	13·58
Protox. Iron - - -	2·71
Lime - - - -	8·07
Magnesia - - - -	1·76
Water - - - -	11·81
	99·83

"Before the blowpipe, melts into a white enamel; with borax, melts into a colourless transparent bead; with carbonate of soda, the same." Dr. Thomson was inclined to consider it a magnesian Stilbite, an opinion which had also been here adopted from its physical characters and behaviour before the blowpipe, but which is not supported by its mineral composition.*

DORANITE.—This zeolitic mineral from Antrim, Dr. Thomson has dedicated to Mr. Patrick Doran, formerly one of the collectors of the survey.

Dr. Thomson's Analysis.

Silica	48·00
Alumina	22·00
Protox. Iron	2·75
Lime	6·00
Magnesia	13·00
Water	7·70
	99·45

"Sp. gr. 2·1588. In aggregated crystals, seemingly cubes; colour, yellowish-white, translucent. Its formula is $\mathrm{Cal.\ S^2 + 3\ M g\ S^2 + 6\ A}\,l\,\mathrm{S + 4\ A}\,q$."

The purity of the specimen analyzed in the last case may perhaps be doubted, but these valuable analyses of Dr. Thomson, so liberally contributed by him, strongly confirm the opinion which has been already stated of the great importance to mineralogical science of a complete analysis of the zeolitic minerals, for which the Ordnance collection, from the number and purity of its specimens, will furnish ample materials: and, it may be added, of other interesting and doubtful groups of minerals.

SULPHURET OF COPPER. VITREOUS COPPER.—The copper ore discovered in the porphyritic district of Barrack Mountain belongs to this species. The lode is principally composed of massive earthy copper-green, occasionally purer and more compact, investing the vitreous copper, which is massive and in small crystals, forming nodules in the lode. The ore is rich. The visible portion of the lode is small, as it merely projects in a thin crest above the water of a small stream when low; but it will be more fully examined by the Hibernian Mining Company.

ADDENDUM TO CHAPTER XII.

POSIDONOMYA *transversa*. Pl. XXXVIII., fig. 9.

Transverse length 1·25″, height ·75″; slightly oblique, transverse; depressed; beaks near the anterior margin, blunt and rounded; surface marked by strong transverse folds. The form of this fossil resembles that of the small P. *minuta* of Goldfuss, but is more transverse. It has also a resemblance to Inoceramus *Cripsii*, but is less oblique and more transverse. It is an external cast in shale.

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* See the red Zeolite of Aedelforss Neus. Jahr. 1841. S. 280.

Locality—Fermanagh, in shale.

Spirifera—*octo-plicata*—(Sow.) Var.—Pl. XXXVIII., fig. 8.

These shells are all crushed, but they approach nearest to the species cited; they are transversely strongly striated; the number of the costæ is more than eight, if the faint marginal fold be included in the number.

Locality—Tyrone, *Benburb.*

Turbo ? *appropinquans*—(Port.)—Pl. XXXVIII., fig. 11.

There is nothing sufficiently distinctive in this small shell to be seized upon. Height ·12″, diameter of base ·15″. Whorls four, rounded, the height of all those above the final whorl being about one half the depth of that whorl; whorls slightly flattened at the top; no markings preserved. This minute shell is nearly allied to many figured species, but not, if closely compared, identical with any. It is more elevated than Natica *glaucinoides* (Sow. in Sil. Res.); less elevated than Turbo *Nerei* (Münster), though it strongly resembles that shell which is also very minute, and approximates to some of Phillips' minute Pleurotomariæ. It is associated with Modiolæ and turrited shells in a micaceous shaly grit.

Locality—Fermanagh. Sheet 1, No. 51.

Note to Chapter XIII.

The flat of Glenullin alluded to as near Garvagh (p. 640) is a beautiful example of those lake-like expansions which have been noticed in respect to the Moyola and Faughan. It is bounded on the north by the basaltic hills of Gortnamoyagh; by the ridge of Coolcoscreaghan on the south; on the west slopes gradually up to the range of Smulgedon and the Dungiven hills; and on the east is bounded by a line of sand and gravel hills. The varied character of the detritus corresponds to its lacustrine condition; at the base is a hard clay gravelly and slightly calcareous, with a few disseminated particles of chalk and flint: then a thick deposit of fine clay and sand, laminated, and the result of a long continued and tranquil action; and on the sloping sides of the hills an accumulation of coarser detritus. The fine sand is occasionally covered with patches of a coarser sandy detritus; and on the east is the coarser and heaped accumulation of gravel, which forms the bounding range. The pebbles, combine fragments of the trap rocks, with others of chalk, flint, mica schist, porphyry, granite, and syenite. The form of this, and of similar expansions, impresses on the mind the idea of a dry lacustrine bed, with which the fine and laminated sandy detritus corresponds; and the variation of the character of detritus shows a corresponding variation in the mode of deposit. The lower clay deposit may have been formed in a bay, which being dammed up, became a lake in which the fine laminated sand and clay were then deposited. The manner in which this damming up was effected is a difficult problem, but the absence of marine fossils in any of the beds, although they occur in the tertiary clays, seems to indicate that though the gravel of the bounding ridge may have been heaped up prior to its elevation above the surface of the sea, and probably under the influence of moving ice, the finer detritus was subsequently deposited in a lake; and it is also not improbable that ice itself was part of the boundary. The lake discharged by the wear of the boundary, and by the melting of the ice, would exhibit the appearances here seen; and it is by no means improbable that the current which produced these effects moved from the south, and partook of a channel character.

GRAVEL—CO. DERRY. (CHAPTER XIII. Page 640.)

Parish.	No. of Sheets.	Rocks in Situ.	Rocks in Gravel.		Remarks.
			Local.	Distant.	
Aghadowey, .	11, 12, 18, 19	T. T 2	T. T 2	6 L. F. Q. Sg. G. Gh. Gp.	
Aghanloo, . .	5, 9	4 A. 5 C. 5 L. 6 L. T. T 2	4 A. F. 6 L. T. Smq.	Smq. Smql. Sm. G. Th.	G. is felspathic and red.
Agivey, . . .	12, 19	„	. .	. .	Surface is principally clay; much used for bricks, &c.
Arboe, . . .	48	4 A. 6 L. T.	. .	. .	Only a small portion in this county.
Artrea, . . .	42	T. T 2	T.	F. Ak. Ared. Smq. Sq. Q. G. Gh. Gtalc. Tg. Th.	
„	47	T. T 2. 6 L.	T 2. 6 L. F.	4 A. Ak. Ax. Sm. Smq. Smg. Q. G. Gh. Gq. Gtalc. Tg. Th. Tgh. S. Tg. STp. Hypersthenic.	All the Slieve Gallion varieties well marked.
„	49	T. T 2	T. T 2.	F. Q. Smq. G. Gh. Gp. Tg. Th.	Do.
Ballinderry, . .	47, 49	T. T 2	T.	F. 4 A. Ak. Ax. Smq. Sg. G. Gh. Gtalc. Ghq. Tg. Th.	Do.
Ballynascreen, .	35, 36, 40, 41	Sm. 2 A 3 A. 6 L. T. &c.	6 L. F. 3 A. 2 A Smq. Sg. Q.	G. Gh. Gtalc. STg. Th. Tg.	Do.
Ballyscullion, .	37, 42, 43	T. T 2	T. T 2	F. Ared. Sm. Smq. Sg. G. Gh. Gtalc. Th. Tg. Tgh. Thp. jasper.	Syenites and greenstones, like S. Gallion rocks; ingredients generally much worn; the T. generally small and not abundant.
Balteagh, . .	17	Sm. 3 A. 4 A 6 L. T. T 2	T. T 2. 6 L. F. A. 4 A. Smq. Smg. Stg. Q.	. .	. .
Banagher, . .	30	Sm. 2 A. 3 A	Gravel clayey pebbles, Smg.	Occasionally G.	Pebbles, all local, excepting the G.
Coleraine, . .	7	T. T 2	T.	6 L. F. Q. Gp.	
Cumber, Lower, .	22, 23, 14, 15	Sm. Lg.	Gravel, sandy, or cly. peb. Sm., &c.	Occasionally G.	Local pebbles, Sm. Smq., Sg., distant occasionally G.
Cumber, Upper, .	22, 23, 28, 29	Sm. Lg. S Tg.			
Desertlyn, . .	46	G. 2 A. 4 A. 6 L. T.	All the local rocks	. .	. .
Desertmartin, .	41, 46	G. 2 A. 4 A. 3 L. 3 A. 6 L.	Do.	T.	
Desertoghill, .	18, 19, 26	T. T 2	T. T 2	F. 3 A. Smq. Smg. Sg. Q. G. Gh. Gtalc. Gq. Tg. Th. jasper, &c.	The granite and hornblendic rocks appear to be from Slieve Gallion.
Drumachose, .	6	T.	T.	F. 6 L. Q. G.	
Dunboe, . .	2, 6, 7	T. T 2	T 2	6 L. F. A. Gh. G. Th. Tg. Schorl rock.	? From Donegal
Dungiven, . .	2	Sm. 2 A. 3 A. 4 A. 6 L. T.	All local	. .	. .
Errigal, . .	18	T.	T.	6 L. F. Smq. Sm. Q. G. Ax.	
„	26	T. Sm. 4 A. 6 L.	6 L. F. A. Sm. T.	Q. G.	
Faughanvale, .	9, 14, 15, 16, 23	Sm. 3 A.	Sm. Smq. Smc. Sg. Sh. S Tg. &c., 3 A.	G. Gp. Gtalc. T.	The granitic porphyry is like that in Clondermot; the G. very felspathic, and similar to the Sl. Gallion rocks.*
Kilcronaghan. .	36	3 A. 3 L.	Do.	F. T. Smq. Sg. Gh. Gtalc. Tg. Th.	Sl. Gallion rocks, distinct.
Killelagh, . .	32	3 A. T. Smq.	T. T 2	F. Q. Tg. Th. G. Gh.	
Killowen, . .	7	T.	T. T 2	6 L. F.	
Lissan, . .	45	Sm. G. STg.	All the local varieties.	. .	
„	48	G. 2 A. 4 A.	4 A. Ax. G. Smq T. Th. Tg.	. .	
Macosquin, . .	6, 7, 11, 12	T. T 2	T. T 2	6 L. F. A. Smq. Sg. G. Gh. Gtalc. Th. Tg.	G. is like the Sl. Gallion rocks.
Maghera, . .	32, 33, 37	T. T 2	T. T 2	F. Q. Sm. Smg. G. Gh. Gtalc. Th. Thp.	Slieve Gallion granite.
Magherafelt, . .	42, 47	4 A. 6 L. T.	A. 6 L. F. T. T 2	3 L. 3 A. Smq. Smqg. Q. G. Gh. Gtalc. Tg. Th. Tgh.	Sl. Gallion rocks, well marked.
Tamlaght Finlagan	9, 16	3 A. Sm.	3 A. 3 Ax. Smq. Smc. Smg. Sq. Sh. Q.	G. Gh. Tg. Th.	The greenstone is probably local; the granite not well marked.
Tamlaght O'Crilly	27, 33, 37	T. T 2	T. T 2	3 A. 6 L. F. Smq. Sm. Smg. Sh. Q. G. Gh. Gtalc. Tg. Th. Thp. jasper.	Greenstones and granites from Slieve Gallion.

* The porphyry in Clondermot is very limited in extent; though therefore the pebbles resemble it, they cannot be considered as proceeding from it; and the granite, though like that of S. Gallion, had most probably a western origin.

GRAVEL—CO. TYRONE. (See CHAPTER XIII. Page 640.)

Parish.	No. of Sheets.	Rocks in Situ.	Rocks in Gravel.		Remarks.
			Local.	Distant.	
Clogher, . .	58, 63, 59, 64	2 A. 3 L. 3 A. 3 Cs.	2 A. 2 Ax. 3 A. 3 L. 3 Cs.	Smq. Smg. Smh. Q. G. Gh. Th. Tp. Tg. T.	
Clonfeacle, . .	54, 55, 61, 62	3 A. 3 Cs. 3 L. 4 A.	3 A. 3 Ax. 3 Cs. 3 L. 4 A. chert.	6 L. F. Smq. Sm. Smg. Sh. Q. G. Gh. Gtalc. Tg. Th. Thp. porphyry	Flints and chalk abundant, primitive rocks do. Porphyry similar to Barrack Mn.
Clonoe, . .	47	3 A. 3 L. 4 A. 6 L. T.	T. T 2. 3 A. Ax. F. Q.	Smq. Smh. G. Gh. Th. Tg.	
Desertcreat, . .	37, 38	G. H. 1 A. 1 S. 2 A. 3 L. 3 A.	G. Gh. Tg. Th. H. 3 L. 3 Ax.	F. Smq.	
Donaghenry, .	38, 39, 46, 47	3 L. 3 A. 4 A. 6 L. T.	3 L. 3 A. 6 L. F. T.	Smq. G. Gh. Tg. Th. Gtalc.	Slieve Gallion rocks, well marked.
Donaghmore, .	46, 54	3 L. 3 A.	3 L. 3 A. Ax. 3 Cs. chert.	F. Sm. Smq. Smg. Q. G. Gh. Gtalc. T. Tg. Th. Tgp. H.	
Drumglass, . .	46, 54	3 L. 3 A.	3 A. 3 L. Ax. chert.	F. Smq. Smg. Q. G. Gh. Tg. Th. T. T 2	
Errigal Keerogue,	52	2 A. 3 A. 3 L.	3 A. chert.	Smq. Smg. Q. G. Th. Thp.	
Kildress, . .	29, 37	Sm. G. H. 2 A. 3 L.	2 A. 2 Ax. 3 L. 3 A. Smq. Smg. G. Gh. Tg. Th. Q.	Porphyriticconglomerate	
Killeeshill, . .	53	2 A. 3 L.	2 A. 2 Ax. 3 L.	F. Smq. Smg. Sh. Sq. Q. G. Gh. Tg. Th. jasper. porphyry.	
Killyman, . .	54, 55	3 A. 4 A.	3 A. 4 A. Ax.	F. Smq. Q. G. Gh. Tg. H. T. T 2	
Kilskeery, . .	56	2 A.	2 A. 2 Ax.	3 L. 3 A.	
Lissan, . . .	21	Sm. G. H.	Smq. Smg. S G. Q. G. Gh. Tg. H.	3 A. Ax.	
Magheracross, .	56	2 A.	2 A. 2 Ax.	3 L. Smq. Smh. G. T. Tg.	
Pomeroy, . .	37, 45, 46	1 S. 2 A. 3 A. 3 L. porph.	1 S. 2 Ax. 3 A. 3 L. porphyry. chest.	F. Smq. Sm. Q. G. Gh. T. Tg. Th.	
Termonmaquirk, .	36, 37, 45	Sm. STg. H. G. 2 A.	Smq. Smg. Smh. G. Gh. Tg. Th.	Q.	
Tullyniskan, . .	46, 47	3 A. 3 L. 4 A.	3 A. 3 L. 4 A.	F. Smq. Q. G. Gh. T. Tg. Th.	

COUNTY ARMAGH.

Parish.	No. of Sheets.	Rocks in Situ.	Local.	Distant.	Remarks.
Tynan, . .	11	3 L. 4 A.	3 L. A.	6 L. F. 2 Ax. Smq. Smc. Q. Tg. Th. Tp. T.	

COUNTY FERMANAGH.

Parish.	No. of Sheets.	Rocks in Situ.	Local.	Distant.	Remarks.
Aghalurcher, .	23	3 L.	3 L. 3 Cs.	2 Ax. Smq. Smg. G. Gh. Q. Tg.	
Rossory, . .	22	3 L.	3 L. 3 Cs.	F. Smq. Smh. Q. Tg.	
Drumkeeran, .	5	3 L.	3 L. 3 Cs.	Smq. Smg. G. Q.	

In the preceding tables, the same characteristics are used to denote the several rocks as on the map, and have been already explained, with the exception of F., which we here use to denote flint. In the column headed, No. of Sheets, only those sheets on which the localities, where the gravels have been examined, occur, are stated, though the parish may extend into several others.

SYNOPTICAL TABLE.

LIST OF FOSSILS.

In submitting the subjoined table, it may be observed that it by no means exhausts the fossils even of the limited district here described. Some might be added to it from the silurian, many from the carboniferous, some from the lias, and from the greensand and chalk a rich supply of novel and most interesting species. Time would not permit the further comparison of the fossils of the older secondary strata (divisons 1 to 5); and as the list is sufficient for practical purposes, and adds, at least, something, however trifling, to the stock of knowledge, it was thought desirable to give it as it is, more especially as it could not be perfected in its subdivisions from the examination of so limited a district. In respect to the fossils of the cretaceous strata (division 6), it is necessary, for their perfect elucidation, to combine the examination of Antrim with that of Derry; but it was also indispensable to collect together all the foreign authorities upon them, as very few have been described in English works; and when a considerable proportion of those works had been obtained, it appeared evident that so many of the Irish cretaceous fossils were new, that to do any justice to their description, another and most extensive set of plates must have been published. There can be little doubt that the remarkable glauconous conglomeritic bed of Tamlaght, so strongly resembling in many respects the conglomeritic bed of the tunnel of Oberau, noticed by Geinitz, will of itself yield a rich harvest of new and most interesting fossils; and when all the localities of Antrim have been fully examined, the chalk of Ireland will be found as rich in fossils as its silurian and carboniferous strata.

EXPLANATION OF THE SYNOPTICAL TABLE.

Column 1. No. of species, noticed in the genus. 2. Names of genera and species. 3, 4. References, the first to the page of the Report, the second to the plate and figure. Fossils not specially noticed in the Report, though collected in the district, are inserted in their proper places. 5, 6, 7, 8. The mineral character of the deposit. 9, 10, 11. Formation, in which the distinguishing figures for divisions and subdivisons are used wherever it is possible to apply them. The subdivisions of the carboniferous strata have been explained; the subdivisions of the lias cannot be attempted in this district; the subdivisions of the chalk are, 1st. The arenaceous or glauconous, or greensand, 6^1. 2nd. The lower chalk 6^2. 3rd. The upper chalk 6^3, a division strictly analogous to that observed in the carboniferous strata. 12, 13. Geological and geographical distribution *within the district described*. 14. Remarks, synonyms, &c.

The species are arranged alphabetically, and those supposed new printed in italics, a rule which only applies to the table, as in the body of the work species are *generally* so printed for the sake of distinctness. The following abbreviations are used in citing the names of authors:—

Ag.	**Agassiz.**
Bl.	**Blainville.**
Br.	**Brown.**
Brong.	**Brongniart.**
A. Bro.	**Brongniart, A.**
Buck.	**Buckland.**
Cuv.	**Cuvier.**
Dal.	**Dalman.**
D'Ar.	**D'Archiac.**
Defr.	**Defrance.**
Dek.	**Dekay.**
D'Or.	**D'Orbigny.**
Eg.	**Egerton.**
Ferus.	**Ferussac.**
Flem.	**Fleming.**
Gei.	**Geinitz.**
Goldf.	**Goldfuss.**
Green	**Green.**
Hib.	**Hibbert.**
His.	**Hisinger.**
K. and D.	**Kock & Dunker.**
Lam.	**Lamarck.**
Lév.	**Léveillé.**
Lin.	**Linneus.**
Lis.	**Lister.**
Lons.	**Lonsdale.**
Mant.	**Mantel.**
Mar.	**Martin.**
Mil.	**Miller.**
Mor.	**Morris.**
Müns.	**Münster.**
Murc.	**Murchison.**
Ow.	**Owen.**
Ph.	**Phillips.**
Ras.	**Raspail.**
Rei.	**Reinecke.**
Roe.	**Roemer.**
Sars	**Sars.**
Schl.	**Schlotheim.**
Sow.	**Sowerby.**
Sto.	**Stokes.**
Stut.	**Stutchbury.**
Tr.	**Troost.**
Von B.	**Von Buch.**
Wahl.	**Wahlenberg.**
Wood.	**Woodward.**
Y. and B.	**Young & Bird.**
Zie.	**Ziethen.**

SYNOPTICAL TABLE.—LIST OF FOSSILS.

No.	Genera and Species.	Reference.		Mineral character of Deposit.				Formation in which found.			Local.		Remarks.
		Page	Plate.	Slate.	Limestone.	Shale.	Sandstone.	Ireland.	Great Britain.	Foreign Locality.	Geologically.	Geographically.	
	ZOOPHYTA.												
1	Achilleum *perreticulatum*,	342	.	.	*	.	.	6^3	.	.	*	.	
1	Ventriculites alternans,	342	.	.	*	.	.	6^2	.	.	.	.	Scyphia alt. (Roe.)
2	,, radiatus, (Mant.)	342	.	.	*	.	.	$6^{2\cdot3}$	Lewes, Brighton.	Westphalia, Moen	.	.	S. Oeynhausii, (Goldf.)
1	Scyphia tubulosa ? (Roe.)	343	.	.	*	.	.	6^2	.	.	*	*	
1	Heteropora cryptopora, (Goldf.)	344	.	.	*	.	.	6^2	.	Berlin, Mæstricht, Neuchatel.	*	*	Ceriopora, (Goldf.)
1	Siphonia cervicornis, (Goldf.)	344	.	.	*	.	.	6^3	.	Greensand, Westphalia.	*	.	Scyphia, (Roe.)
1	Coscinopora infundibuliformis, (Goldf.)	343	.	.	*	.	.	6^3	.	Westphalia, in Chalk-marl.	*	.	
1	Cellepora favosa ? (Goldf.)	340	.	.	*	.	.	3^2	Dudley.	Eifel.	*	*	Hook Point.
1	Fenestella flabellata, (Ph.)	324	xxii. A. 4. xxii. 1.	.	*	*	.	3	Bolland, Harrowgate, Kirby Lons.	.	*	.	This is probably the form of the older divisions, and F. irregularis of the newer.
2	,, flustriformis,	.	.	.	.	.	.		.	.	.	.	
3	,, *intertexta*,	324	xxii. A. 3.	.	.	*	.	3^3	.	.	*	*	
4	,, irregularis, (Ph.)	325	xxii. A. 2.	.	.	*	.	3	.	.	*	.	Retepora, (Ph.)
5	,, laxa ? (Ph.)	323	.	.	*	.	.	3	Bolland, N. and S. Devon.	.	*	.	
6	,, polyporata, (Ph.)	323	xxii. A. 1. xxii. 3.	.	.	*	.	3	.	.	*	.	
7	,, tenuifila, (Ph.)	324	.	.	.	*	.	3	.	.	*	.	
1	Retepora prisca, (Goldf.)	325	xxii. A. 5.	.	*	.	.	3^2	.	Eifel.	*	*	Not Fenestella prisca, (Lons.)
2	,, membranacea, (Ph.)	340	.	.	*	*	.	3	Bolland.	.	*	.	
1	Glauconome pluma ? (Ph.)	340	.	.	*	.	.	$3^{3\cdot4}$	Bolland.	.	*	.	Retepora pluma, (Phil.)
1	Ptilodictya *dichotoma*,	339	xxi. 3.	*	.	.	.	1	.	.	*	*	
1	Millepora repens ?	339	.	*	.	.	.	1	Wenlock limestone Coalbrookdale.	Gottland, Baltic.	*	*	Tramore.
1	Gorgonia assimilis, (Lons.)	322	.	*	.	.	.	1	Wenlock limestone	.	*	*	
2	,, *capillaris*,	323	xxi. 1.	*	.	.	.	1	.	.	*	*	
3	,, *regularis*,	323	xx. 6.	*	.	.	.	1	.	.	*	*	
4	,, *undulata*,	322	xx. 8.	*	.	.	.	1	.	.	*	*	
1	Graptolithus convolutus, (His.)	319	xix. 5.	*	.	.	.	1	.	Furudal—Dal.	*	*	Prionotus, (His.)
2	,, foliaceus, (Lons.)	320	xix. 9.	*	.	.	.	1	Llandeilo flags.	.	*	*	
3	,, folium, (His.)	321	xx. 5.	*	.	.	.	1	.	Furudal.	*	*	
4	,, *distans*,	319	xix. 4.	*	.	.	.	1	.	.	*	*	

5	,, pristis, (His.)	320	xix. 10.	*	.	.	.	1	. . .	Dalecarlia.	*	*	
6	,, sagittarius, (His.)	320	xix. 8. xx. 1.	*	.	.	.	1	. . .	Furudal, do.	*	*	
7	,, scalaris? (His.)	321	xx. 3.	*	.	.	.	1	. . .	Scania, &c.	*	*	
8	,, *Sedgewickii,*	318	xix. 1.	*	.	.	.	1	. . .	. . .	*	*	
9	,, *tenuis,*	319	xix. 7,	*	.	.	.	1	. . .	. . .	*	*	
1	Syringopora geniculata, (Ph.)	337	xxii. 6.	.	*	.	.	3	Ashfell, Mendip.	. . .	*	*	
2	,, laxa? (Ph.)	338	. . .	.	*	.	.	3	Ashfell.	. . .	*	.	
3	,, ramulosa, (Goldf.)	337	. . .	.	*	.	.	3	Bolland, Mendip.	Olne.	*	*	
4	,, reticulata, (Goldf.)	337	xxii. 7.	.	*	.	.	3	Ashford.	Olne, Moscow, Groningen.	*	.	
1	Catenipora escharoides, (Lam.)	325	. . .	*	.	.	.	1	Mid-Ludlow, Wen. limestone, Llandeilo flags.	Eifel, Norway, Essen, America.	*	.	
2	,, labyrinthica, (Goldf.)	325	xx. 9.	*	.	.	.	1	. . .	Groningen, Gottland, Lake Huron.	*	*	Portrane, abundant. Devonian?
1	Vincularia *multangularis,*	339	xxii. A. 7.	.	*	.	.	3^1	. . .		*	*	
1	Favosites capillaris, (Ph.)	327	. . .	.	*	.	.	3	Gordal.	. . .	*	*	
2	,, fibrosa, (Goldf.)	327	. . .	.	*	.	.	3	Aymestry limest. N. and S. Devon.	Eifel, N. America.	*	*	County of Down, not Armagh.
3	,, Gottlandica, (Goldf.)	326	. . .	.	*	.	.	3	Ludlow, S. Devon, Aymestry limest. to Carc. sandstone.	Gottland, Eifel, Drummond Island.	*	.	
4	,, polymorpha, (Goldf.)	326	xxi. 2.	*	.	.	.	1	U. Ludlow, Aymestry le.	Eifel, Bensberg, Namur.	*	*	
5	,, *serialis,*	327	xxii. A. 6.	.	*	.	.	3	. . .	. . .	*	*	
6	,, tumida, (Ph.)	326	xxii. 4.	.	.	*	.	3	Harrowgate, Kir. Lons. Arran.	. . .	*	.	
1	Stromatopora concentrica, (Lons.)	326	. . .	*	.	.	.	1	Wenlock limestone	Eifel.	*	.	From Tramore.
2	,, polymorpha, (Goldf.)	326	xx. 10.	*	.	.	.	1	S. Devon.	Eifel, Bensberg.	*	*	
1	Astrœa basaltiformis,	333	. . .	.	*	.	.	3^2	. . .	Bensberg.	*	*	Columnaria sulcata, (Goldf.) Cyathophyllum basa. (Ph.)
2	,, hexagona, (Goldf.)	332	xxiii. 1. 2.	.	*	.	.	3^2	. . .	Eifel, Bensberg.	*	.	Cyatho. hexa. (Goldf.)
3	,, *irregularis,*	333	xxiii. 3. 4.	.	*	.	.	3^2	. . .	. . .	*	.	
1	Lithodendron *coarctatum,*	335	xxii. 5.	.	*	.	.	3^2	. . .	. . .	*	.	
2	,, fasciculatum,	335	. . .	.	*	.	.	3^2	Ribblesdale, Bristol, Northumd.	. . .	*	.	Parkinson and Fleming; not Martin or Phillips.
3	,, irregulare, (Ph.)	336	. . .	.	*	.	.	3	Ashfell, Northum.	. . .	*	.	
4	,, longiconicum, (Ph.)	336	. . .	.	*	.	.	3^2	. . .	. . .	*	.	
5	,, sociale, (Ph.)	335	. . .	.	*	.	.	3^2	Settle.	. . .	*	.	
1	Turbinolia *fibrosa,*	329	xx. 7.	*	.	.	.	1	. . .	. . .	*	.	? Madrepora duplicata. (Martin.)
2	,, mitrata, (His.)	331	. . .	.	.	*	.	3	. . .	. . .	*	*	
3	,, turbinata, (His.)	331	. . .	.	.	*	.	3	. . .	. . .	*	*	
4	,, verrucosa, (His.)	331	. . .	.	.	*	.	3^2	. . .	. . .	*	.	
1	Turbinolopsis *elongata,*	329	xxiv. 9.	.	*	.	.	1	. . .	. . .	*	.	
1	Cyathophyllum ceratites, (His.)	331	. . .	.	*	.	.	3	. . .	Eifel, Bensberg.	*	.	
2	,, flexuosum, Goldf.)	330	. . .	.	*	.	.	3	. . .	Eifel.	*	.	
3	,, fungites, (Goldf.)	332	. . .	.	*	.	.	3	Bolland, Bowes, Bristol, Durham.	. . .	*	*	
4	,, vermiculare, (Goldf.)	331	. . .	.	*	.	.	3	. . .	Eifel.	*	.	
1	Strombodes *favosum,*	338	. . .	.	*	.	.	3	. . .	. . .	.	.	
1	Intricaria *obscura,*	326	xxi. 4.	*	.	.	.	1	. . .	. . .	.	.	Doubtful.

SYNOPTICAL TABLE.—*continued.*

No.	Genera and Species.	Reference.		Mineral character of Deposit.				Formation in which found.			Local.		Remarks.
		Page	Plate.	Slate.	Limestone.	Shale.	Sandstone.	Ireland.	Great Britain.	Foreign Locality.	Geologically.	Geographically.	
	CRINOIDEA.												
1	*Trochocrinites lævis*, . . .	345	xv. 1.	*	.	.	.	1	. . .	. . .	*	*	
1	Actinocrinites amphora, . . .	347	xv. 4, 5, 6.	.	*	.	.	3^2	. . .	. . .	*	*	Melocrinites amp. (Goldf.)
2	„ decadactylus, (Goldf.) .	349	. . .	.	*	.	.	3^2	. . .	Ems.	*	*	
3	„ *icosi dactylus*, . .	348	xv. 7.	.	*	.	.	3	. . .	. . .	*	*	
4	„ triacontadactylus, (Mil.) .	348	xvi. 2, 7, 8, 9.	.	*	.	.	3	Bolland, Mendip, Bristol, S. Devon.	Eifel.	*	*	
5	„ columns, . . .	348	xvi. 1.	.	*	.	.	3	. . .	. . .	*	.	Columns only.
1	Rhodocrinites verus, (Mil.) . .	349	. . .	.	.	*	.	3	Dudley, Mendip, Bristol.	Eifel.	*	*	
1	Cyathocrinites pinnatus, (Goldf.) .	349	. . .	.	*	.	.	3	N. and S. Devon.	Eifel, Harz.	*	*	Portrane, Devonian ?
1	Platycrinites granulatus, (Mil.) . .	350	xvi. 4.	.	*	.	.	3	Bolland, Mendip.	. . .	*	.	
2	„ lævis, (Mil.) . .	350	. . .	.	*	*	.	3	Bolland, Bristol.	Ratingen, Namur, Belgium.	*	.	
3	„ rugosus, (Mil.) . .	350	xvi. 3, 13.	.	*	.	.	3^2	Bolland, Mendip.	Baireuth.	*	*	
1	Poteriocrinites conicus, (Ph.) . .	350	xvi. 12.	.	*	.	.	3^2	Bolland.	. . .	*	*	
1	Gilbertsocrinus *simplex*, . . .	351	xvi. 5.	.	*	.	.	3^2	. . .	. . .	*	*	
1	Pentremites ovalis, (Goldf.) . .	351		.	*	.	.	? 3	N. Devon.	Ratingen, Dusseldorf, Eifel.	*	*	Devonian ?
1	Pentacrinites basaltiformis, (Mil.) .	351	. . .	.	.	*	.	5	Lias.	Wirtemberg.	.	.	
	ECHINIDA.												
1	Ananchytes conoideus, (Goldf.) . .	354	xviii. 1.	.	*	.	.	6^3	. . .	Belgium.	*	.	
2	„ ovatus, (Lam.) . .	354	xvii. 3. xviii. 2.	.	*	.	.	$6^{2\cdot3}$	. . .	Westphalia, Rouen, Brussels, Sweden, Russia.	.	.	
3	„ *pyramidatus*, . .	355	. . .	.	*	.	.	6^3	. . .	. . .	.	.	
4	„ sulcatus, (Goldf.) . .	354	. . .	.	*	.	.	6^3	. . .	Mæstricht.	*	.	
1	Holaster *aequalis*, . . .	355	xvii. 2.	.	*	.	.	6^3	. . .	. . .	*	.	
2	„ planus, . . .	355	. . .	.	*	.	.	6^2	Low. chalk, Sussex, Yorkshire.	. . .	*	.	Spatangus planus, (Mant.)
3	„ Sandoz ? (Ag.) . .	355	xvii. 1.	.	*	.	.	6^2	. . .	. . .	*	*	
1	Micraster cor-anguinum, . .	356	. . .	.	*	.	.	6^3	Lyme Regis., Up. Chalk, Sussex, Yorkshire.	Berlin, Paris, Westphalia.	*	.	Spatangus cor. (Mant.)
1	Pyrina ——— ? (Ag.) . .	357	. . .	.	*	.	.	$6^{2\cdot3}$	. . .	. . .	*	.	
1	Diadema corollaris, . . .	358	xvii. 4.	.	*	.	.	$6^{2\cdot3}$	South-downs.	. . .	.	.	Cidaris cor. (Park.) (Mant.)

1	Cidaris *acrocidaris*,	358	xviii. 4.	.	*	.	.	6			*	*	
2	„ *Benburbensis*,	352	xvi. 10.	.	.	*	.	3^3			*	.	
3	„ vesiculosa, (Goldf.)			.	*	.	.	6^2	Lewes.	Neuchatel, Westphalia, Maestricht.	*	.	
4	„ vetusta, (Ph.)	353		.	.	*	.	3^3	Coalbrookdale, Northumberland.		*	.	
1	Galerites abbreviatus, (Goldf.)	356		.	*	.	.	6^3		Westphalia.	*	.	
2	„ albo-galerus,	356		.	*	.	.	6^3	Up. chalk, Sussex.	Hercynia.	.	.	Conulus alb. (Mant.)
3	„ sub-rotundus, (Mant.).	357		.	*	.	.	6^3	Do.	Brandenburg.	*	.	
4	„ vulgaris,	356	xviii. 3.	.	*	.	.	6^3	Lyme Regis.	Rouen, &c.			Conulus vul. (Mant.)
	ANNELIDA.												
1	Entobia *antiqua*,	360	xxi. 5.	*	.	.	.	1			*	*	
2	„ *cretacea*,	360		.	*	.	.	6^3			.	.	
1	Lumbricaria *antiqua*,	361	xxiv. 7.	*	.	.	.	1			*	*	
2	„ *gregaria*,	361		*	.	.	.	1			*	*	
1	Aphrodita ?	362	xxiv. 8.	*	.	.	.	1			*	*	
1	Serpula gordialis, (Schl.)			.	.	.	.	.			.	.	
2	„ var. serpentina, (Goldf.)	364		.	*	.	.	6^3		Essen, Osnabruck, &c.	*	*	In Quader-sandstein, near Dresden.
3	„ var. *contorta*,	364		.	*	.	.	6^3			*	*	
4	„ lævis, (Goldf.)	363		.	.	*	.	? 5		Greensand at Essen.	*	*	
5	„ socialis, (Goldf.)	362	xxv. A. 9.	.	.	*	.	3^2		Eifel, Baireuth, Wurtemburg.	*	*	In Jura limestone, Wurtemberg. Greensand, Ratisbon.
6	„ *subannulata*,	363		.	*	.	.	3^2			*	*	? S. epithonia, var. (Goldf.)
7	„ *sub-cincta*,	362		.	*	.	.	3^2			*	*	
1	Spirorbis *minuta*,	363	xii. 3. b.	.	.	*	.	3^1			*	*	
2	„ omphalodes,	363		.	.	*	.	3^1		Eifel, Bensberg.	*	*	Serpula omp. (Goldf.)
1	Dentalium *tenue*,	118		.	.	.	*	5			.	.	
	CRUSTACEA.												
1	*Remopleurides Colbii*,	256	i. 1.	*	.	.	.	1			*	*	
2	„ *dorso-spinifer*,	256	i. 3.	*	.	.	.	1			*	*	
3	„ *lateri-spinifer*,	256	i. 2.	*	.	.	.	1			*	*	
4	„ *longi-capitatus*,	257	i. 5.	*	.	.	.	1			*	*	
5	„ *longi-costatus*,	257	i. 6.	*	.	.	.	1			*	*	
1	Ceraurus *globiceps*,	257	i. 7.	*	.	.	.	1			*	*	
1	Paradoxides Bucephali,	258	i. 8.	*	.	.	.	1		West Gothland.	*	*	Entomostracites buc. (Wahl.)
1	Ampyx *Austinii*,	261	i. B. 1, 2.	*	.	.	.	1		? Christiania.	*	*	? A. mammillatus, (Sars).
2	„ *baccatus*,	262	iii. 11.	*	.	.	.	1			*	*	
3	„ *Sarsii*,	260	i. 9, 10.	*	.	.	.	1		Christiania.	*	*	A. rostratus, (Sars) var.
1	Trinucleus Caractaci (Murc.)	262	i. B. 3.	*	.	.	.	1	Caradoc sandstone		*	*	
2	„ *elongatus*,	263	i. B. 7.	*	.	.	.	1			*	*	
3	„ *latus*,	264	i. B. 11, 12.	*	.	.	.	1	Caradoc sandstone		*	*	T. fimbriatus, (Murc.)
4	„ radiatus, (Murc.)	264	i. B. 9.	*	.	.	.	1	Caradoc sandstone		*	*	
5	„ seticornis,	263	i. B. 8.	*	.	.	.	1		Furudal.	*	*	Asaphus set. (His.)
1	Harpes *Doranni*,	267	v. 4.	*	.	.	.	1			*	*	
2	„ *Flanaganni*,	268	v. 5, 6, 7.	*	.	.	.	1			*	*	
1	Brontes *Hibernicus*,	270	v. 8.	*	.	.	.	1			*	*	

SYNOPTICAL TABLE.—*continued.*

No.	Genera and Species.	Reference.		Mineral character of Deposit.				Formation in which found.			Local.		Remarks.
		Page	Plate.	Slate.	Limestone.	Shale.	Sandstone.	Ireland.	Great Britain.	Foreign Locality.	Geologically.	Geographically.	
1	Arges *plano spinosus*,	272	v. 9.	*	.	.	.	1	. . .	. . .	*	*	Paradoxides bimucronatus, (Murc.)
1	Nuttainia *Hibernica*,	274	iv. 1. v. 1, 2, 3.	*	.	.	.	1	. . .	. . .	*	*	
2	,, *obscura*,	274	xxiv. 4.	*	.	.	.	1	. . .	. . .	*	*	
1	Phacops *Brongniartii*,	282	ii. 8. iii. 8 d.	*	.	.	.	1	Wenl. limestone	U. S. America.	*	*	Calymene macrophthalma, (Brong.) C. Downingii, (Murc.)
2	,, *Dalmanni*,	282	ii. 7. iii. 7 d.	*	.	.	.	1	. . .	. . .	*	*	From Tramore.
3	,, *Jamesii*,	283	iii. 10.	*	.	.	.	1	. . .	. . .	*	*	
4	,, *Murchisonii*,	283	ii. 9. iii. 9.	*	.	.	.	1	. . .	. . .	*	*	
5	,, *truncato-caudatus*,	281	ii. 1, 2, 3, 4.	*	.	.	.	1	. . .	. . .	*	*	
6	,, tuberculatus,	284	ii. 10.	.	.	.	.	.	. . .	Eifel.	*	*	Calymene tub. (Murc.)
1	Calymene Blumenbachii, (Brong.)	285	iii. 1.	*	.	.	.	1	Wenl. limestone	Gothland.	*	*	
2	,, *brevi-capitatus*,	286	iii. 3.	*	.	.	.	1	. . .	. . .	*	*	
3	,, pulchella, (Dal.)	286	iii. 2.	*	.	.	.	1	. . .	. . .	*	*	
1	Amphion *gelasinosus*,	289	iii. 4.	*	.	.	.	1	. . .	. . .	*	*	
2	,, *multi-segmentatus*,	291	iii. 6.	*	.	.	.	1	. . .	. . .	*	*	
3	,, *pseudo-articulatus*,	291	iii. 5. xxiv. 1.	*	.	.	.	1	. . .	. . .	*	*	
1	Asaphus dilatatus, (Dal.)	293	xxiv. 3.	*	.	.	.	1	. . .	. . .	*	*	
2	,, *latifrons*,	292	vii. 5, 6.	*	.	.	.	1	. . .	. . .	*	*	
3	,, *marginatus*,	293	vii. 7.	*	.	.	.	1	. . .	. . .	*	*	
1	Isotelus *arcuatus*,	298	ix. 2, 3.	*	.	.	.	1	. . .	. . .	*	*	
2	,, gigas, (Dek.)	295	vii. 1.	*	.	.	.	1	. . .	U. S. America.	*	*	
3	,, *intermedius*,	299	ix. 5.	*	.	.	.	1	. . .	. . .	*	*	From Tramore.
4	,, læviceps,	299	ix. 4.	*	.	.	.	1	. . .	. . .	*	*	Asaphus læ. (Dal.)
5	,, *ovatus*,	297	viii. 5.	*	.	.	.	1	. . .	. . .	*	*	
6	,, palpebrosus,	.	. . .	*	.	.	.	1	. . .	East Gothland.	*	*	Asaphus pal. (Dal.)
7	,, planus, (Dek.)	295	vii. 2. 3. viii. 1, 2, 3, 7.	*	.	.	.	1	. . .	U. S. America.	*	*	
8	,, Powisii, (Murc.).	297	vi. 1.	*	.	.	.	1	Caradoc sandstone	. . .	*	*	Asaphus Powisii, (Murc.)
9	,, *rectifrons*,	298	ix. 1.	*	.	.	.	1	. . .	. . .	*	*	
10	,, sclerops, (Green)	299	x. 1, 2.	*	.	.	.	1	. . .	. . .	*	*	
1	Illænus centrotus, (Dal.)	300	x. 3, 4, 5, 6.	*	.	.	.	1	. . .	East Gothland.	*	*	
2	,, crassicauda, (Dal.)	301	x. 7, 8, 9.	*	.	.	.	1	. . .	Dalecarlia.	*	.	Entomostracites crassicauda (Wahl.)
3	,, ? *quadrato-caudatus*,	302	xxiv. 2.	*	.	.	.	1	. . .	. . .	*	*	
1	Ogygia ? *rugosa*.	302	v. 10.	*	.	.	.	1	. . .	. . .	*	*	
1	*Phillipsia Jonesii*,	308	xi. 3, 5.	.	*	.	.	3	. . .	. . .	*	*	
2	,, *Kellii*,	307	xi. 1.	.	*	.	.	3	. . .	. . .	*	*	
3	,, *Maccoyii*,	309	xi. 6.	.	*	.	.	3	. . .	. . .	*	*	? Asaphus truncatulus, (Ph.)
4	,, *ornata*,	307	xi. 2.	.	*	.	.	3	. . .	. . .	*	*	

1	*Griffithides globiceps*,	311	xi. 9.	.	*	.	.	3	Bolland.	. . .	*	*	Asaphus glo. (Ph.)
2	,, *longiceps*,	310	xi. 7.	.	*	.	.	3	. . .	. . .	*	.	
3	,, *longi-spinus*,	312	xxiv. 12.	.	*	.	.	3	. . .	. . .	*	.	
4	,, *platyceps*,	311	xi. 8.	.	*	.	.	3	. . .	. . .	*	*	
1	Dithyrocaris *Colei*,	314	xii.	.	.	*	.	3¹	. . .	. . .	*	.	
2	,, *orbicularis*,	316	. . .	.	.	*	.	3¹	. . .	. . .	*	*	
1	Limulus trilobitoides, (Buck.)	316	xxiv. 11.	.	.	*	.	3¹	Derbyshire.	. . .	*	*	Entomolithus monoculites, (lunatus) (Mar.)
1	Cypris scoto-burdigalensis, (Hib.)	316	xxiv. 13 c.	.	.	*	.	3	. . .	. . .	*	*	
2	,, *sub-rectus*,	316	xxiv. 13 b.	.	.	*	.	3	. . .	. . .	*	.	
	CONCHIFERA—Monomyaria.												
1	Mytilus *cinctus*,	426	xxv. A. 5, 6.	*	.	.	.	1	. . .	. . .	*	.	
2	,, *semirugatus*,	430	xxv. A. 7.	*	.	.	.	1	. . .	. . .	*	*	
1	Modiola, bipartita, (Sow.)	122	. . .	.	.	.	*	5	Lower greensand.	Upper Oolite, Rinteln, Raberstein.	*	*	
2	,, *Brycei*,	425	xxxiii. 7.	*	.	.	.	1	. . .	. . .	*	*	
3	,, compressa ? (Goldf.)	122	. . .	.	.	*	.	5	Stonesfield.	Coral Rag, Linden.	*	*	Mytilus, (Goldf.)
4	,, *expansa*,	425	xxxiii. 6.	*	.	.	.	1	. . .	. . .	*	*	
5	,, Hillana, (Sow.)	122	. . .	.	*	.	.	5	Lias	Lias-marl, Ockerhutte.	*	*	
6	,, lingualis, (Ph.)			.	*	.	.	3	Castleton.	. . .	.	.	
7	,, *Macadami*,	432	xxxiv. 13, 14, 15	.	.	*	.	3	. . .	. . .	.	.	
8	,, minima, (Sow.)	122	. . .	.	.	.	*	5	Lias.	Adenberg, Upper Lias-marl.	*	*	3 Varieties. Roemer.
9	,, Nerei, (Müns.)	424	xxxiii. 10.	*	.	.	.	1	. . .	. . .	*	*	Mytilus Nc. (Müns.)
10	,, oblonga, (Roe.)	122	. . .	.	.	*	*	5	. . .	Hildesheim, Portd. Rock.	*	*	
11	,, scalprum, (Sow.)	122	. . .	.	*	*	*	5	Lias, Lyme.	Lias-marl, Metz, Lias sandstone, Goppingen.	*	.	
12	,, *securiformis*,	425	xxxiii. 8.	*	.	.	.	1	. . .	. . .	*	*	
13	,, *subparallela*,	433	xxxiv. 16.	.	.	*	.	3	Bolland, Derbysh.	. . .	*	.	
1	Pinna *costata*,			.	*	.	.	3	Bath Oolite.	. . .	*	.	
2	,, cuneata, (Ph.)	125	. . .	.	.	.	*	5	. . .	. . .	*	*	
3	,, Hartmanni, (Zie. and Goldf.)	124	. . .	.	*	.	*	5	. . .	Lias limest. Vahingen, Lias sand. Goppingen.	*	.	
4	,, *inæquicostata*,	437	. . .	.	*	.	.	3	? Derbyshire.	. . .	*	.	P. flabelliformis, var. (Mar.)
5	,, inflata, (Ph.)			.	*	.	.	3	Bolland.	. . .	.	.	
6	,, lanceolata, (Sow.)	125	. . .	.	.	*	.	5	Coral Rag.	Coral Rag, Toul.	*	.	
7	,, mitis ? (Ph.)	125	. . .	.	*	.	.	5	Oxford clay.	. . .	*	*	
1	Avicula *contorta*,	126	xxv. A. 16.	.	.	*	.	5	. . .	. . .	*	.	
2	,, Goldfussii, (K. and D.)	.	. . .	.	.	*	.	5	. . .	Grunenplan, Hottenson,	.	.	
3	,, inæquivalvis, (Sow.)	126	. . .	.	.	*	.	5	Lias Oolite, Oxd.cl.	Common.	*	*	
4	,, modiolaris, (Müns. and Goldf.)	126	. . .	.	.	*	.	5	. . .	Pappenheim, in Jura kalk.	.	.	
5	,, orbicularis, (Murc.)	425	. . .	*	.	.	.	1	Carc. sandstone.	. . .	*	*	
6	,, ————?	126	. . .	.	.	.	*	5	. . .	. . .	.	.	
1	Pterinea *Thompsoni*,	431	xxv. A. 40.	.	.	*	.	3	. . .	. . .	*	*	

SYNOPTICAL TABLE.—*continued.*

No.	Genera and Species.	Reference.		Mineral character of Deposit.				Formation in which found.			Local.		Remarks.
		Page	Plate.	Slate.	Limestone.	Shale.	Sandstone.	Ireland.	Great Britain.	Foreign Locality.	Geologically.	Geographically.	
1	Gervillia angusta ? (Goldf.)	127	. . .	.	.	.	*	6^1	. . .	St. Kassian, Tyrol.	.	.	
2	,, *elongata,*	438	. . .	.	.	.	*	3	. . .	. . .	*	.	
3	,, laminosa ? (Ph.)	438	. . .	.	.	.	*	3	Bolland.	. . .	*	.	
4	,, squamosa, (Ph.)	438	. . .	.	.	*	.	3	Bolland.	. . .	*	*	
1	Inoceramus cinctus, (Goldf.)	127	. . .	.	.	*	.	5	. . .	Lias shale, Altdorf, Hildesheim.	*	*	
2	,, *contortus,*	422	xxxiii. 5.	*	.	.	.	1	. . .	. . .	*	*	
3	,, Cripsii,	116	. . .	.	*	.	.	6	Chalk marl.	Dieppe.	*	.	
4	,, *gryphus,*	567	. . .	.	*	.	.	3	. . .	. . .	*	*	
5	,, *Hamiltoni,*	126	. . .	.	.	.	*	6	. . .	. . .	*	*	
6	,, involutus, (Sow.)	.	. . .	.	.	.	*	6	Chalk.	. . .	*	*	
7	,, *pernoides,*	567	xxxviii. 5.	.	.	.	*	3	. . .	. . .	*	*	
8	,, *priscus,*	423	xxxiii. 1, 2, 3.	*	.	.	.	1	. . .	. . .	*	*	
9	,, *transversus,*	423	xxxiii. 11.	*	.	.	.	1	. . .	. . .	*	*	
10	,, trigonus, (Müns.)	422	xxxiii. 4.	*	.	.	.	1	. . .	Trans. limestone, Presseck.	*	*	
11	,, vetustus, (Sow.)	442	. . .	.	.	*	.	3	Derbysh. Yorksh.	Ratingen	*	.	
1	Posidonomya *complanata,*	472	xxxiv. 12.	.	.	*	.	3	. . .	. . .	*	.	
2	,, minuta,	.	. . .	.	.	.	.	4	. . .	. . .	.	.	
3	,, *transversa,*	746	xxxviii. 9.	.	.	*	.	3	. . .	. . .	*	.	
4	,, venusta, (Müns.)	424	xxv. A. 4.	*	.	.	.	1	. . .	Schübelhammer, Presseck.	*	*	
1	Pecten, æquicostatus ? (Lam.)	129	. . .	.	.	.	*	5	. . .	Greensand, Bavaria, Saxony.			? P. longicollis, (Roe.)
2	,, arenosus, (Ph.)	435	. . .	.	.	*	.	5	Bolland, Derbysh.	. . .	*	.	Elongated var.
3	,, calvus, (Goldf.)	128	. . .	.	.	*	.	.	. . .	Amberg.	*	.	
4	,, cingulatus, (Ph.)	.	. . .	.	.	.	.	.	. . .	Lias, Amberg, Streilberg, &c.	.	.	
5	,, deornatus, (Ph.)	.	. . .	.	.	.	.	.	. . .	. . .	.	.	
6	,, dissimilis, (Flem.)	.	. . .	.	.	.	.	3	Bolland, Linlithg.	. . .	.	.	
7	,, ellipticus, (Ph.)	436	. . .	.	.	.	*	3	Bolland.	. . .	*	.	
8	,, granosus, (Sow.)	437	. . .	.	.	*	.	3	Bolland.	. . .	*	.	Phillips' var.
9	,, hemisphericus, (Ph.)	.	. . .	.	.	.	*	3	Bolland.	. . .	*	.	
10	,, interstitialis, (Ph.)	435	. . .	.	*	.	.	3	Hawes, Bolland.	. . .	.	.	
11	,, Ottonis, (Goldf.)	436	xxxvi. 10.	.	.	.	*	3	. . .	Psammite, Silesia.	*	.	? var. P. granosus, (Sow.)
12	,, *ovato-costatus,*	437	. . .	.	.	.	*	3	. . .	. . .	*	*	
13	,, plicatus, (Sow.)	435	. . .	.	.	*	.	3	. . .	. . .	.	.	Not P. plicatus, (Ph.)
14	,, quinquecostatus, (Sow.)	129	. . .	.	*	.	*	6^1	Up. Greensand.	Low. Chalk, Green Sand, Westphalia, Hercynia.	.	.	" Quader-sandstein, Königsstein."

15	,, quadricostatus ? (Sow.)	.	.	.	*	.	.	6¹?	Low. greensand.	Chalk, greensand.	.	.	? Distinct from P. 5 costatus.
16	,, *semi costatus*,	436	xxxvi. 9.	.	*	.	.	3	.	.	*	.	Carnteel, Co. Tyrone.
17	,, sublævis, (Ph.)	123	.	.	.	*	.	5	Lias.	.	*	*	*Young and Bird, not Roemer.*
18	,, subulatus, (Müns. and Goldf.)	125	.	.	*	.	.	5	.	Lias, Altdorf, Amberg, &c.	*	*	? P. sublævis, (Roe.)
19	,, textilis, (Müns. and Goldf.)	129	.	.	*	.	.	5	.	Altdorf.	*	.	
20	,, textorius, (Schl. and Goldf.)	128	.	.	*	.	.	5	.	Lias, Altdorf.	*	.	? P. virguliferus, (Ph.)
21	,, transversus, (Sow.)	437	.	.	.	*	.	3	Barnstaple.	.	*	*	
22	,, Valoniensis, (Defr.)	127	xxv. A. 11.	.	.	*	.	?5	.	Valogne.	*	.	
23	,, vimineus, (Sow.)	128	.	.	.	*	.	5	Calcs. grit. Brora, Coral Rag.	Normandy, Wurtemberg, Altdorf.	*	*	
24	,, vitreus, (Roe.)	.	.	.	.	*	.	5	.	Low. Coral Rag, Hanover.	.	.	
25	,, ——? casts,	129	.	.	.	.	.	.	.	.	.	.	
1	Lima alternans, (Roe.)	129	.	.	.	*	.	5	.	Lias-marl, Gosler.	*	.	
2	,, antiquata, (Sow.)	130	.	.	*	.	.	5	Lias shale.	Inf. Ool. Haute Saone.	*	*	Not L. antiquata, (Müns. and Goldf.)
3	,, cardiformis, (Sow.)	.	.	.	.	*	.	.	Kelloway's Rock.	.	.	.	Plagiostoma car. (Sow.)
4	,, duplicata,	131	.	.	.	*	.	5	Coral Rag.	Infr. Oolite, Rabenstein, Geisingen.	*	*	Plagiostoma du. (Sow.)
5	,, gigantea,	131	.	.	*	*	*	5	Inferior Oolite Lias, Lower Lias.	Normandy, Hanover, Baden, Goppingen.	.	.	Plagiostoma gig. (Sow.)
6	,, Hermanni, (Goldf.)	130	.	.	*	.	.	5	.	Altdorf, Waldensheim.	*	.	
7	,, pectinoides, (Sow.)	130	.	.	.	*	.	5	Lias.	Vachingen.	*	.	Not L. pectinoides, (Goldf.)
8	,, proboscidea ? (Sow.)	130	.	.	*	*	.	5	Inferior Oolite.	Normandy, Wurtenburg, Baireuth.	*	.	
9	,, punctata, (Sow.)	131	.	.	*	.	.	5	Lias.	Low. Oolite, Thurnau, Rabenstein.	*	*	
10	,, rustica ? (Sow.)	130	.	.	.	*	.	5	Coral Rag.	.	*	*	Phillips' variety.
1	Plicatula spinosa ? (Sow.)	131	.	.	.	*	.	.	Lias.	Ardennes, Baireuth.	.	.	
1	Ostrea acuminata, (Sow.)	131	.	.	.	*	.	5	Inferior Oolite.	Boblaye, &c.	*	.	
3	,, —new sp.	131	.	.	.	*	.	5	.	.	*	*	
1	Gryphæa bullata ? (Sow.)	.	.	.	.	*	.	.	Coral Rag.	.	.	.	
2	,, columba,	132	.	.	*	.	*	6	Chalk.	Rouen, Havre, Sardinia.	*	.	Freiberg, Potsdam, &c &c.
3	,, cymbium, (Lam.)	.	.	.	*	*	.	5	.	Lias, Baireuth, Altdorf.	*	.	
4	,, dilatata, (Sow.)	.	.	.	.	*	.	5	Inferior Oolite.	.	*	.	Forms corresponding to these varieties occur, but appear to pass into each other.
5	,, incurva, (Sow.)	132	.	.	.	*	.	5	Lias.	Bavaria, Wurtemburg.	*	.	
6	,, MacCullochii, (Sow.)	132	.	.	.	*	.	5	Lias.	Elwangen, Ellingen.	*	.	
1	Exogyra conica, (Sow.)	.	.	.	.	.	*	6¹	Greensand.	Chalk-marl, Mæstricht.	*	.	Greensand, Hercynia.
2	,, lævigata, (Sow.)	132	.	.	.	.	*	6¹	Greensand.	.	*	.	

SYNOPTICAL TABLE.—*continued.*

No.	Genera and Species.	Reference.		Mineral character of Deposit.				Formation in which found.			Local.		Remarks.
		Page	Plate.	Slate.	Limestone.	Shale.	Sandstone.	Ireland.	Great Britain.	Foreign Locality.	Geologically.	Geographically.	
	CONCHIFERA—Dimyaria.												
1	Pholadomya longirostris, (Schl.)	118	.	.	.	*	.	5	.	Near Panki.	*	*	Cardium, (Schl.) Up. Jura kalk.
2	„ *myacites*,	119	.	.	.	*	.	5	.	.	*	*	
3	„ ventricosa, (Goldf.)	118	.	.	.	*	.	5	.	Oolite, Bavaria.	*	.	
1	Solen pelagicus, (Goldf.)	441	xxxvi. 4.	.	*	.	.	3	.	Eifel.	*	*	
1	Panopæa elongata, (Roe.)	119	xxxiv. 19.	.	.	*	.	5	.	Willershausen.	*	*	In Belemnite beds, (Roe.)
1	Solemya primæva, (Ph.)	441	.	.	*	.	.	3	Northumberland.	.	*	.	
1	Lutraria *primæva*,	441	xxxvi. 5.	.	*	.	.	3	.	.	*	.	
1	Amphidesma *axiniformis*,	439	xxxvi. 6.	.	.	*	.	3	.	.	*	.	
2	„ carbonaria,	438	xxxvi. 8.	.	.	*	.	3	Coalbrookdale.	.	.	.	? Venus car. (Sow.)
3	„ *deltoida*,	439	xxxvi. 7.	.	.	*	.	3	.	.	.	.	? Cypricardia del. (Ph.)
4	„ *depressa*,	439	.	.	.	*	.	3	.	.	*	*	
1	Sanguinolaria *attenuata*,	435	xxxvi. 3.	.	.	.	*	3	.	.	*	*	
2	„ *maxima*,	434	xxxvi. 1.	.	*	.	.	3	.	.	*	*	
3	„ *oblonga*,	434	xxxvi. 2.	.	*	.	.	3	.	.	*	.	
4	„ *plicata*,	433	xxxiv. 18.	.	.	*	.	3	.	.	*	.	
5	„ sulcata? (Ph.)	.	.	.	*	.	.	3	Northumberland.	Eifel.	*	.	
6	„ *transversa*,	434	xxxiv. 21.	.	.	*	*	3	.	.	*	.	
7	„ *undata*,	434	xxxiv. 20.	.	.	*	.	3	.	.	*	*	
1	Corbis? ovalis, (Ph.)	119	.	.	.	*	.	5	Kelloway's Rock.	.	*	.	
1	Lucina *Du Noyeri*,	571	xxxviii. 12.	.	.	*	.	3	.	.	*	*	Allied to L. proavia, (Goldf.)
1	Astarte elegans, (Sow.)	119	.	.	*	.	.	5	Great Oolite Lias, Inferior Oolite, Oxford clay, &c.	Hildesheim, Rabenstein.	*	*	
2	„ *lenticularis*, (Sow.)	442	.	.	*	.	.	6	.	.	*	.	MSS.
3	„ tetragona, (Mor.)	119	.	.	.	*	.	5	Lias, Bristol.	.	*	.	MSS. Morris.
1	Venus elliptica, (Ph.)	440	.	.	.	*	.	3	Northumberland.	.	*	.	
2	„ ——N. S.	442	.	.	*	.	.	6	.	.	*	.	
1	Pullastra *bistriata*,	440	xxxvi. 13.	.	.	*	.	3	.	.	*	.	
2	„ ——?	119	.	.	.	.	*	5	.	.	.	.	
1	Cardium decussatum, (Mant.)	116	.	.	*	.	.	6	Chalk marl.	.	*	.	
2	„ striatulum, (Sow.)	120	.	.	.	*	.	5	Infr. Oolite.	.	*	.	
3	„ truncatum, (Sow.)	120	.	.	.	*	.	?5	Lias.	Boll. Altdorf.	*	.	C. pectinatum, (Y. and B.)
4	„ ——?	442	.	.	*	.	.	6	.	.	*	.	
1	Cypricardia *simplex*,	426	.	*	.	.	.	1	.	.	*	*	
2	„ *tricostata*,	441	xxxiv. 17.	.	*	.	*	3	.	.	*	.	
1	Isocardia axiniformis, (Ph.)	.	.	.	*	.	.	3	Northumberland.	.	*	*	Desertmartin.

2	" cretacea, (Goldf.)						*	6		Chalk, Westphalia.	*	*	Sallagh Braes, Antrim.
3	" oblonga, (Sow.)	440			*			3			*		
1	Arca *cylindrica*,	428	xxxiv. 9.	*				1			*	*	
2	" *dissimilis*,	428	xxxiv. 5.	*				1			*	*	
3	" Eastnori, (Murc.)	427	xxxiv. 3.	*				1	Caradoc sandstone		*	*	
4	" *obliqua*,	429	xxxiv. 6.	*				1			*	*	
5	" pulchra ? (Sow.)	119				*		5	Gt. Oolite.		*		
6	" *radiata*, (Sow.)	442			*			6			*		MSS.
7	" *regularis*,	427	xxxiv. 2.	*				1			*	*	
8	" *subtruncata*,	427	xxxiv. 1.	*				1			*	*	
9	" *transversa*,	428	xxxiv. 4.	*				1			*	*	
1	Cucullæa cucullata, (Goldf.)	120				*		5		Infr. Oolite, Thurnau, Rabenstein.	*	*	
1	Pectunculus *ambiguus*,	430	xxxiv. 11.	*				1			*	*	
2	" *Apjohnii*,	429	xxxiv. 8.	*				1			*	*	
3	" *semi-truncatus*,	429	xxxiv. 7.	*				1			*	*	
1	Nucula acuta ? (Sow.)	430	xxxiv. 10.	*				1	Coalbrookdale.		*	*	Var. imbricata.
2	" antiquata ? (Sow.)	120					*	5	Low. greensand.		*		
3	" *lævi-rostrum*,	439	xxxvi. 12.			*		3			*		
4	" *radiata*,	430	xxxvi. 11.	*				1			*	*	
5	" rostralis, (Goldf.)	120					*	5		Lias marl, Banz, Thurnau.	*	*	
6	" subglobosa ? (Roe.)	120					*	5		Lias marl, Gosler.	*	*	
7	" tumida, (Ph.)	439				*		3	Bolland, Northumberland.		*	*	Var.
8	" undulata, (Ph.)	439				*		3	Bolland.		*	*	
9	" variabilis ? (Sow.)	120					*	5	Great Oolite.		*	*	
1	Trigonia *incerta*,	442				*		3			*	*	
1	Unio Listeri, (Sow.)	121				*		5	Infr. Oolite.		*		
2	" Nillsoni, (K and D.)	121				*		5		Lias marl and shale, Exten.	*		
3	" peregrinus ? (Ph.)	121				*		5	Cornbrash.		*		
4	" trigonus ? (Roe.)	121				*		5		Low. Lias, Exten.	*	*	
5	" ——?	568	xxxviii. 6.				*	3			*	*	
1	Pachyodon concinnus, (Stut.)	120			*			5	Infr. Oolite.	Wurtemburg.	*	*	Unio con. (Sow.) (Switzerland.)
2	" crassiusculus, (Stut.)	120				*		5	Lias.		*		
3	" hybridus, (Stut.)	122				*		5	Mag. lime.		*		" crass. (Sow.)
4	" imbricatus, (Stut.)	122				*		5	Lias, Bristol.		*		" hyb. (Sow.)
5	" ovalis, (Sow.)	121				*		5	Bristol.		*		Var. rugosus, (Stut.)
1	Lysianassa rhombifera, (Goldf.)	119				*		5		Lias, Banz. Altdorf.	*	*	
	RUDISTA.												
1	Pleurorhynchus minax, (Ph.)	440			*			3^2			*		
	BRACHIOPODA.												
1	Orbicula *cincta*,	446	xxxii. 15.			*		3			*	*	
2	" *oblongata*,	445	xxxii. 13.	*				1			*	*	
3	" lævigata, (Müns.)	445	xxxii. 11, 12.	*				1		Elbersreuth.	*	*	
4	" nitida, (Ph.)	446	xxxii. 14			*		3	Bowes, Coalbrookdale.		*		Var.
5	" plana, (Müns.)	445				*		3		Schübelhammer.			
6	" *sub-rotunda*,	445	xxxii. 10.	*				1			*	*	

SYNOPTICAL TABLE.—*continued.*

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		Page	Plate.	Slate.	Limestone.	Shale.	Sandstone.	Ireland.	Great Britain.	Foreign Locality.	Geologically.	Geographically.	
1	Terebratula ambigua, (Ph.)			.	*	.	.	3	Northumberland.		*	.	Cookstown, &c.
2	" biplicata, (Sow.)			.	*	.	*	6	U. greensand.		.	.	
3	" carnea, (Sow.)			.	*	.	.	6	Chalk.	Rouen, Dieppe.	*	.	
4	" crispata ? (Murc.)	455		*	.	.	.	1	Wen. limestone.		*	*	
5	" crumena, (Sow.)	568		.	.	.	*	3^1			*	*	
6	" ferita (Von B.)	567	xxxviii. 4.	.	.	.	*	3^1			*	*	
7	" flexistria, (Ph.)	581		.	*	.	.	3^2			.	.	
8	" hastata, (Sow.).			.	*	.	.	3^2	Derbysh., Bristol.		.	.	
9	" intermedia, (Sow.)			.	.	.	*	6^1			*	.	
10	" lacunosa, (Murc.)	455	xxv. A. 1.	*	.	.	.	1	Up. and Lr. Ludlow, Wenlock, &c.		*	*	Not T. lacunosa, (Dal.)
11	" lateralis, (Sow.)			.	*	.	.	3			*	*	
12	" Mantelliana, (Sow.)?			.	*	.	.	5			.	.	Resembles this species.
13	" nucula, (Murc.)			*	.	.	.	1	W. limestone to Old Red.		*	*	
14	" obovata, (Sow.)			.	.	.	*	5	Cornbrash, Inf. ool.		*	.	
15	" octoplicata, (Sow.)			.	*	.	.	6	Chalk.		*	.	
16	" ornithocephala, (Sow.)			.	*	*	.	5	Cor. Ool. Kellow. Rock Inf. Ool.	Normandy, Buxweiler.	*	.	
17	" ovata, (Sow.)			.	*	.	.	6	Chalk.		*	.	
18	" pentaedra, (Ph.)			.	*	.	.	3^2	Bolland.		*	.	
19	" pleurodon, (Ph.)	581		.	*	.	.	3	Bolland, Kirby, Lonsdale.		*	.	
20	" plicatella, (Dal.)			*	.	.	.	1			.	.	T. lacunosa, (Murc.)
21	" plicatilis, (Sow.)			.	*	.	.	6	Chalk.		*	.	
22	" pugnus, (Sow.)			.	*	.	.	3^2	Derbyshire.		*	.	(Mar.)
23	" pulchra, (Murc.)			*	.	.	.	1	U. Ludlow.		*	.	
24	" radialis, (Ph.)			.	*	*	.	3	Bolland.		*	.	
25	" reniformis, (Sow.)			.	*	*	.	3	Bolland.		.	.	
26	" sacculus, (Sow.)			.	*	.	.	3	Bolland, Derbysh.		*	.	(Mar.)
27	" semi globosa, (Sow.)			.	*	.	*	6	Chalk.		.	.	
28	" Wilsoni, (Sow.)			*	.	.	.	1	Wen. L., L. Lud., Aymestry.		*	*	
1	Uncites gryphus,	455	xxv. A. 8.	*	.	.	.	1			*	*	
1	Atrypa acuminata,	459		*	.	*	.	3^2			*	*	Var. *obsoleta*. Tereb. ac. (Sow.)
2	" *gibbera*,	460	xxxviii. 1.	.	*	.	.	3^2			*	*	
3	" glabra,			.	*	.	.	3^2	Bolland, Isle of Man.		*	.	Spirifer gla. (Ph.)
4	" var. oblata,			.	*	.	.	3^2			*	.	

5	,, var. obtusa,	.	.	.	*	.	.	.	.	.	.	.	.	.	
6	,, globularis ? (Ph.)	519	.	.	.	.	.	3^1	.	.	.	.	.	.	Doubtful.
7	,, plano sulcata, (Ph.	.	.	.	*	.	.	3^1	.	.	.	.	*	.	
8	,, *sublobata,*	567	xxxviii. 2.	.	.	.	.	3^1	.	.	.	.	*	*	
9	,, *transversa,*	455	.	*	.	.	.	1	.	.	.	.	*	*	
1	Spirifera attenuata, (Sow.)	.	.	.	*	.	.	3	Bolland.	.	.	.	.	.	
2	,, bisulcata, (Sow.)	561	.	.	*	.	.	.	.	.	.	.	.	.	
3	,, cuspidata, (Sow.)	.	.	.	*	.	.	$3^{2.4}$	.	.	.	.	.	.	
4	,, cyrtæna,	454	xxxvii. 4.	.	.	.	*	1	.	.	.	.	*	*	Delthyris cyr. (Dal.)
5	,, distans, (Sow.)	.	.	.	*	.	.	3^2	Bolland.	.	.	.	*	.	
6	,, elliptica, (Phil.)	.	.	.	*	.	.	3	Bolland.	.	.	.	.	.	
7	,, glabristria, (Phil.)	.	.	.	*	.	.	3	Bolland.	.	.	.	.	.	
8	,, imbricata, (Sow.)	.	.	.	*	.	.	3	Bolland, Derbysh.,	.	.	.	.	.	(Northumberland.)
9	,, *laxa,*	459	xxxvii. 6.	.	.	.	*	3	.	.	.	.	*	.	
10	,, linguifera, (Phil.)	.	.	.	*	.	.	3^2	Bolland.	.	.	.	.	.	
11	,, octoplicata, (Sow.)	746	xxxviii. 8.	.	.	*	.	.	Kirby Lonsdale,	.	.	.	.	.	(Derbyshire.)
12	,, *partita,*	567	xxxviii. 3.	.	.	.	*	3^1	.	.	.	.	.	.	
13	,, pinguis,	.	.	.	*	.	.	3	Bolland, Derbysh.	.	.	.	.	.	
14	,, plano-sulcata,	.	.	.	*	.	.	3^2	Bolland.	.	.	.	.	.	
15	,, rotundata, (Sow.)	459	.	.	.	*	.	3	.	.	.	.	*	.	Var.
16	,, semi-circularis, (Phil.)	.	.	.	.	*	.	3^3	Yorkshire, Isle of Man.	.	.	.	.	.	
17	,, senilis, (Phil.)	.	.	.	*	.	.	3	Bolland.	.	.	.	.	.	
18	,, speciosa, (Schl.)	.	.	.	*	.	.	.	.	.	.	.	.	.	
19	,, striata, (Mart.)	.	.	.	*	.	.	3^2	Bolland, Derbysh.	.	.	.	.	.	
20	,, undulata, (Sow.)	.	.	.	.	*	.	3	.	.	.	.	.	.	
1	Orthis alternata, (Murc.)	451	.	*	.	.	.	1	Caradoc sandstone	.	.	.	*	*	
2	,, analoga, (Phil.)	457	.	.	*	.	.	3	Bolland.	.	.	.	.	.	
3	,, arachnoidea,	.	.	.	.	.	*	3^2	Stradone, &c.	.	.	.	*	.	Doubtful species.
4	,, bilobata, (Murc.)	453	.	.	.	.	*	1	Caradoc sandstone Llandeilo flags.	.	.	.	*	*	
5	,, callactis β. (Dal.)	451	xxv. A. 2, 3.	*	.	.	.	1	Caradoc sandstone	.	.	.	*	*	
6	,, *cancellata,*	450	xxxii. 19.	*	.	.	.	1	.	.	.	.	*	*	
7	,, *concentrica,*	452	xxxvii. 1.	*	.	.	.	1	.	.	.	.	*	*	Var. O. expansa. (Murc.)
8	,, *corrugata,*	450	xxxii. 17, 18.	*	.	.	.	1	.	.	.	.	*	*	
9	,, depressa,	450	.	*	.	.	.	1,3	Llandeilo F., to Lower Ludlow.	.	.	.	.	.	Leptæna dep. (Dal.)
10	,, expansa, (Murc.)	452	.	*	.	.	.	1	Caradoc sandstone	.	.	.	*	*	
11	,, filiaria, (Ph.)	458	.	.	.	*	.	3	Bolland, Derbysh.	.	.	.	.	.	Terebratula Michelini, (Lév.)
12	,, grandis, (Murc.)	452	xxxii. 25.	*	.	.	.	1	Caradoc sandstone	.	.		*	*	
13	,, hybrida, (Murc.)	451	.	*	.	.	.	1	Wenlock lime-stone and shale.	.		.	*	*	
14	,, *intercostata,*	454	xxxvii. 3.	*	.	.	.	1	.	.	.	.	*	*	
15	,, lineata, (Mar.)	.	.	.	*	.	.	3	.	.	.	.	.	.	
16	,, lunata ? (Murc.)	451	.	*	.	.	.	1	Lower Ludlow to Old Red.	.	.	.	.	.	
17	,, orbicularis,	458	xxv. 11.	.	.	*	.	3	Upper Ludlow.	.	.	.	*	*	
18	,, pecten, (Dal.)	453	.	*	.	.	.	1	Caradoc sandstone, Llandeilo flags.	.	.	.	*	*	
19	,, *pulchra,*	459	xxv. 13.	.	.	*	.	3	.	.	.	.	*	*	
20	,, resupinata,	.	.	.	*	.	.	3	Bolland, Derbysh.	.	.	.	.	.	
21	,, *rugifera,*	453	xxxvii. 2.	*	.	.	.	1	.	.	.	.	*	*	

SYNOPTICAL TABLE.—*continued.*

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		Page	Plate.	Slate.	Limestone.	Shale.	Sandstone.	Ireland.	Great Britain.	Foreign Locality.	Geologically.	Geographically.	
22	Orthis rugosa, (Dal.)	458	.	.	*	.	.	3	.	.	*	*	Leptæna, (Dal.) (Ph.)
23	„ rustica, (Murc.)	.	.	*	.	.	.	1	Wenlock lime.	.	*	*	
24	„ sericea, (Murc.)	450	xxxii. 23, 24.	*	.	.	.	1	Caradoc sandstone, Llandeilo flags.	.	*	*	Leptæna se. (Murc.)
25	„ testudinaria, (Murc.)	451	.	*	.	.	.	1	Caradoc sandstone, Llandeilo flags.	?	*	*	? O. testudinaria, (Dal.)
26	„ umbraculum, (Von B.)	456	xxxvii. 5.	.	.	*	.	3	.	.	*	.	
27	„ var. crenistria, (Ph.)	458	xxv. 12.	.	.	*	.	3	.	.	*	.	
28	„ vespertilio ? (Murc.)	453	.	*	.	.	.	1	Caradoc sandstone, Llandeilo flags.	.	*	*	
29	„ virgata, (Murc.)	453	.	*	.	.	.	1	Caradoc sandstone,	.	*	*	
1	Leptæna duplicata, (Murc.)	454	.	*	.	.	.	1	Caradoc sandstone, Llandeilo flags.	.	*	*	
2	„ euglypha, (Dal.)	454	.	*	.	.	.	1	Caradoc sandstone, to Lower Ludlow.	.	*	*	Productus, (Dal.)
1	Producta aculeata, (Murc.)	.	.	.	*	.	.	3^1	.	.	.	.	Strophomena.
2	„ aurita, (Ph.)	.	.	.	*	.	.	3	.	.	.	.	
3	„ comoides, (Ph.)	.	.	.	*	.	.	3	.	.	.	.	
4	„ comoides, (Sow.)	.	.	.	.	*	.	3	.	.	.	.	Orthis ? P. Edelburgensis ? (Ph.)
5	„ concinna, (Sow.)	.	.	.	*	.	.	3	Bolland, Derbysh.	.	.	.	
6	„ fimbriata, (Sow.)	.	.	.	*	.	.	.	Bolland, I. of Man	.	.	.	
7	„ granulosa, (Ph.)	.	.	.	*	.	.	3	Bolland.	.	.	.	
8	„ hemispherica, (Sow.)	.	.	.	.	*	.	3	.	.	.	.	
9	„ small var.	.	.	.	*	.	.	3^2	.	.	.	.	
10	„ Var. gigantea, (Sow.)	.	.	.	*	.	.	3	Alstone Moor, Derbyshire, &c.	.	.	.	
11	„ Martini, (Sow.)	.	.	.	*	.	.	3	Derbyshire.	.	.	.	
12	„ punctata, (Sow.)	.	.	.	*	*	.	3	Yorkshire, Cumberland, Buxton.	.	.	.	
13	„ pustulosa, (Ph.)	.	.	.	*	.	.	3	Bolland.	.	.	.	
14	„ quincuncialis, (Ph.)	.	.	.	*	.	.	3	Bolland.	.	.	.	
15	„ rugata, (Ph.)	.	.	.	.	*	.	3	Bolland.	.	.	.	
16	„ scabricula, (Sow.)	.	.	.	*	.	.	3	Bristol, Coalbrookdale.	.	.	.	
17	„ semi-reticulata, (Mar.)	.	.	.	*	.	.	3	.	.	.	.	
18	„ var. antiquata,	.	.	.	.	.	.	.	.	.	.	.	
19	„ sulcata, (Sow.)	.	.	.	*	.	.	3	.	.	.	.	
1	Lingula attenuata, (Murc.)	.	xxxii. 4.	*	.	.	.	1	Llandeilo flags	.	*	*	
2	„ Beanii, (Ph.)	443	.	.	.	.	*	.	Inferior Oolite.	.	*	*	

3	,, *brevis*,	443	xxxii. 2.	*	.	.	.	1	. . .	. . .	*	*	
4	,, lata, (Murc.)	443	xxxii. 1, 3.	*	.	.	.	1	Lower Ludlow.	. . .	*	*	
5	,, mytiloides, (Sow.)	444	xxxii. 7.	.	*	.	.	3	Durham.	. . .	*	*	
6	,, parallela, (Ph.)	444	xxxii. 6, 8, 9.	.	.	*	.	3	Northumberland.	. . .	*	*	
7	,, squamiformis, (Ph.)	443	xxxii. 5.	.	.	*	.	3	Bolland.	. . .	*	*	
	CEPHALOPODA—POLYTHALAMACEA.												
1	Conularia *elongata*,	393	xxix. A. 2.	*	.	.	.	1	. . .	. . .	*	*	
2	,, quadrisulcata, (Sow.)												
3	,, Var. Silur,	393	xxix. A. 3.	*	.	.	.	1	Wen. limestone.	Canada, Sweden.	*	*	
4	,, Var. Carbo.	393	xxix. A. 4, 5.	.	*	*	.	3	Bristol, Glasgow.	Berlin.	.	.	
1	Orthoceras *affine*,	387	xxvii. 9.	.	.	*	*	3	. . .	Dalecarlia.	*	*	O. conicus, (His.)
2	,, *breviconicum*,	373	xxviii. 8.	*	.	.	.	1	. . .	. . .	*	*	
3	,, Breynii, (Mar.)	388	. . .	.	*	.	.	3	Derbyshire.	. . .	*	*	var. (Sow.)
4	,, Brongniartii, (Tr.)	368	xxviii. 4.	*	.	.	.	1	. . .	Nashville, U. S.	*	*	
5	,, calamiteum, (Müns.)	365	xxv. 1.	*	.	.	.	1	. . .	Fichtelgebirge.	*	*	
6	,, canaliculatum, (Murc.)	390	. . .	.	*	.	.	3	Lowr. Ludlow, Wen. limestone.	. . .	*	.	
7	,, circulare, (Sow.)	388	. . .	.	.	*	.	3	Dudley.	. . .	*	*	
8	,, *complanato septum*,	374	xxviii. B. 1.	*	.	.	.	1	. . .	. . .	*	*	
9	,, cylindraceum, (Sow.)	390	. . .	.	.	*	.	3	N. Devon.	. . .	*	*	
10	,, *elongato-cinctum*,	372	xxvii. 2.	*	.	.	.	1	. . .	. . .	*	.	
11	,, Gesneri ? (Mar.)	390	. . .	.	*	.	.	3	Derbyshire.	. . .	.	.	O. Canaliculatum, (Murc.) Not O. Gesneri, (Ph.)
12	,, *gracile*,	366	xxv. 2.	*	.	.	.	1	. . .	. . .	*	*	
13	,, gregarium, (Murc.)	386	xxvii. 8.	.	.	*	*	3	Lowr. Ludlow.	. . .	*	.	O. gre. (Müns.) O. inæquiseptum, (Ph.) O. Cylindracea, (Flem.)
14	,, *incertum*,	374	xxviii. 7.	*	.	.	.	1	. . .	. . .	*	*	
15	,, irregulare ? (Müns.)	375	. . .	*	.	.	.	1	. . .	Elbersreuth, Prague	.	.	
16	,, *latissimum*,	390	xxxv. 2.	.	*	.	.	3	. . .	. . .	*	.	
17	,, lineatum, (His.)	370	xxvii. 3. xxviii. 1.	*	.	.	.	1	. . .	Schübelhammer.	*	*	In "Clymenienkalk."
18	,, maximum, (Müns.)	388	xxxv. 3.	.	*	.	.	3	. . .	Elbersreuth.	*	.	
19	,, *per-annulatum*,	367	xxv. 5, 6.	*	.	.	.	1	. . .	. . .	*	*	
20	,, *Pomeroense*,	370	xxvi. 4, 5.	*	.	.	.	1	. . .	. . .	*	*	
21	,, pyramidale, (Flem.)	389	. . .	.	.	.	*	3	Carbfs. limestone	. . .	*	*	? O. unguis, (Ph.)
22	,, regulare ? (Müns.)	377	xxvii. 4.	*	.	.	.	1	. . .	Elbersreuth.	*	*	
23	,, reticulatum ? (Ph.)	390	. . .	.	*	.	.	3	Bolland.	. . .	.	.	
24	,, sub-annulare,	368	xxv. 7, 8.	*	.	.	.	1	. . .	Elbersreuth.	*	*	
25	,, *sub-arcuatum*,	374	xxviii. 9.	*	.	.	.	1	. . .	. . .	*	*	
26	,, *sub-costatum*,	371	xxvi. 6.	*	.	.	.	1	. . .	. . .	*	*	
27	,, sub-flexuosum, (Müns.)	372	xxviii. 3.	*	.	.	.	1	? Bolland, S. Devon.	Elbersreuth.	*	*	? O cinctum, (Ph.)
28	,, *sub-imbricatum*,	391	xxvi. 6.	*	.	.	.	1	? S. Devon.	. . .	*	.	? O. laterale, (Ph.)
29	,, *sub-undulatum*,	373	xxviii. 2.	*	.	.	.	1	. . .	. . .	*	*	
30	,, *tenui-cinctum*,	371	. . .	*	.	.	.	1	. . .	. . .	*	*	O. cinctus (Müns.) O. cincta, (Sow.) Not O. cinctum, (Ph.)
31	,, *triangulare*,	375	xxviii. A. 3.	*	.	.	.	1	. . .	. . .	*	*	? Var. of O. anceps, (Müns.)
32	,, tubicinella, (Sow.)	367	xxv. 3, 4.	*	.	.	.	1	S. Devon.	Westphalia.	*	*	2 Varieties.
33	,, *tumidum*,	373	xxviii. 5, 6.	*	.	.	.	1	. . .	. . .	*	*	

SYNOPTICAL TABLE.—*continued.*

No.	Genera and Species.	Reference.		Mineral character of Deposit.				Formation in which found.			Local.		Remarks.
		Page	Plate.	Slate.	Limestone.	Shale.	Sandstone.	Ireland.	Great Britain.	Foreign Locality.	Geologically.	Geographically.	
34	Orthoceras unguis ? (Ph.)	389		.	.	.	*	3	?		*	*	
35	„ doubtful,	387		.	*	*	.	3			.	.	
1	Actinoceras Simsii, (Sto.)	391		.	*	.	.	3			*	*	Co. Down.
2	„ (New spe.)	392		.	*	.	.	3			*	*	
1	Gomphoceras subfusiforme, (Müns.)	381	xxiv. 5.	*	.	.	.	1		Schübelhammer.	*	*	
2	„ subpyriforme, (Müns.)	381	xxviii. A. 1.	*	.	.	.	1		Gattendorf.	*	*	
1	*Koleoceras Ballii,*	380	xxviii. A. 2.	*	.	.	.	1			*	*	
2	„ *pseudo-regulare,*	379	xxvi. 2.	*	.	.	.	1			*	*	
3	„ *pseudo-speciosum,*	380	xxvi. 3.	*	.	.	.	1			*	*	
1	Phragmoceras arcuatum, (Murc.)	382	xxviii. A. 5.	*	.	.	.	1	Lower Ludlow.		*	*	
2	„ Brateri, (Müns.)	383	xxviii. B. 3.	*	.	.	.	1		Gattendorf.	*	*	In "Clymenienkalk."
3	„ compressum, (Murc.)	382	xxviii. B. 2.	*	.	.	.	1	Lower Ludlow.		*	*	
4	„ *inequiseptum,*	382	xxviii. A. 4.	*	.	.	.	1			*	*	
5	„ ———— ?	383	xxviii. B. 4.	*	.	.	.	1			*	*	
1	Cyrtoceras obliquatum, (Ph.)	384	xxviii. B. 5.	.	.	*	.	3	S. Devon.		*	*	
2	„ New. sp.			.	*	.	.	3			.	.	
3	„ ———— ?	383	xxviii. B. 6.	*	.	.	.	1			*	*	
1	Lituites, cornu-arietis, (Murc.)	383	xxviii. B. 7.	*	.	.	.	1	Llandeilo Flags.		*	*	Var.
1	Nautilus biangulatus, (Sow.)	405		.	*	.	.	3	Bolland, Bristol.		*	.	
2	„ cariniferus, (Sow.)			.	*	.	.	3	Bolland, Coalbrookdale.		*	.	
3	„ dorsalis,	405		.	*	.	.	3	Bolland.		*	.	
4	„ elegans,	406		.	*	.	.	6	Chalk, Sussex.	Chalk, Rouen.	*	.	
5	„ globatus, (Sow.)			.	*	.	.	3	Bolland.		*	*	
6	„ goniolobus, (Ph.)	406	xxix. A. 8.	.	.	*	.	3	Bolland.		*	*	
7	„ Mantellii, (Sow.)	406		.	*	.	.	6²	Low. Green Sand, Kent.		*	*	MSS.
8	„ multicarinatus, (Sow.)	405		.	*	.	.	3	Cumberland.		*	.	
9	„ *perplanatus,*	403	xxix. A. 11.	.	.	*	.	3		Trans. Lime, Gothland.	*	*	? N. complanatus, (His.) Not N. comp. (Sow.)
10	„ planidorsatus, (Müns.)	403	xxxv. 1.	.	*	.	.	3		Gattendorf.	*	*	Goniatites pla. (Müns.)
11	„ quadratus ? (Flem.)	404	xxix. A. 10.	.	.	*	.	3	West Lothian.		*	*	
12	„ radiatus, (D'Orb.)	406		.	*	.	.	6²		Rouen.	*	.	? (Sow.)
13	„ subsulcatus, (Ph.)	405		.	.	*	.	3	Bolland, Coalbrookdale.		*	*	(Var.)
14	„ sulcatus, (Sow.)	404		.	*	.	.	3	Bowes, Coalbrookdale, Derb.		*	.	
1	Hamites, (several species,)	409		.	*	.	.	6²			.	.	
1	Turrilites, (several species,)	400		.	*	.		6²			.	.	

1	Goniatites *granosus*,	407	xxix. A. 9.	.	.	*	.	3			*	*	
2	„ obtusus, (Ph.)	407		.	.	*	.	3	Bolland.		*	*	
3	„ sphericus, (Sow.)			.	*	.	.	3	Derbysh. Bolland, Isle of Man.		*	*	Ammonites, (Sow.)
4	„ striatus, (Sow.)	407		.	.	*	.	3	Derbysh. Bolland.		*	*	Var.
5	„ striolatus, (Ph.)	407		.	*	.	.	3	Yorkshire.		*	.	
6	„ truncatus ? (Ph.)	407		.	.	*	.	3	?		*	*	
7	„ ——?	407		.	.	*	.	3			*	*	
1	Ammonites alternatus, (Wood.)	408		.	*	.	.	6	Red chalk, Norf.		.	.	
2	„ do. var. (Sow.)	408		.	*	.	.	6			*	*	MSS.
3	„ armatus, (Sow.)	138		.	.	*	.	5	Lias and Oxford Clay.	Ox. clay, Norma. Haute Saone.	.	.	
4	„ Bucklandi, (Sow.)	132		.	*	.	.	5	Lias, Yorkshire.	Lias, Normandy, Heidelberg.	*	*	
5	„ Bucklandi, jun. (Sow.)	132		.	.	*	.	5			*	*	
6	„ cassida ? (Ras.)	409		.	*	.	.	6			*	.	" Neocomien," (D'Orb.)
7	„ Conybeari, (Sow.)	132		.	.	*	.	5	Lias, Yorkshire, Western Islands.	Buxweiller, South Germany.	*	.	
8	„ elegans ? (Sow.)	134		.	.	*	.	5	Lias. Inf. Oolite.		*		
9	„ fissicostatus, (D'Orb.)	408		.	*	.	.	6	Speeton Clay, Yorkshire.	Ardennes, Varennes, Wissant.	.	.	(Var.)
10	„ hastatus, (Y. and B.)	138		.	.	*	.	5	L. Lias, Yorksh.		.	.	
11	„ *intermedius*,	136		.	*	*	.	5			*	.	
12	„ Johnstonii, (Sow.)	136		.	.	*	.	5	Lias, Somerset.		*	*	
13	„ læviusculus ? (Sow.)	134		.	.	*	.	5	Inferior Oolite.	Inferior Oolite, Normandy.	*	.	
14	„ Lamberti, (Sow.)	136		.	.	*	.	5	Portland.		*	*	
15	„ Lewesiensis, (Sow.)	408		.	*	.	.	6^2	Chalk, Sussex.	Essen, Rouen.	.	.	
16	„ *Mac Donnelli*,	134	xxix. A. 12.	.	.	*	.	5			*	.	
17	„ multicostatus, (Sow.)	133		.	.	.	*	5	Lias, Bath.		*	*	
18	„ planorbis, (Sow.)	138		.	.	*	.	5	Lias, Somerset.		*	*	
19	„ radians, (Rei.)	133		.	*	.	.	5			*	*	
20	„ rotiformis ? (Sow.)	139		.	.	*	.	5	Lias, Bath.		*	*	
21	„ *Sampsoni*,	138	xxix. 13.	.	*	.	.	5			*	.	
22	„ striatulus, (Sow.)	133		.	.	*	.	5	Inf. Oolite, Lias.		*	*	
23	„ subradiatus ? (Sow.)	134		.	.	*	.	5			*	.	
24	„ *new species*,	409		.	*	.	.	6			*	.	
1	Baculites anceps, (Lam.)			.	*	.	.	6^2		Balsberg.	.	.	
2	„ Faujasii, (Lam.)	116		.	*	.	.	6^2	Chalk, Sussex. Norfolk.	Mæstricht, Sweden, Aix-la-chapelle.	*	.	
3	„ obliquatus, (Sow.)			.	*	.	.	6	Chalk, Sussex.	Malmo.	*	.	
	MONOTHALAMACEA.												
1	Bellerophon *alatus*.	471	xxxiii. 9.	*	.	.	.	1			*	*	
2	„ apertus, (Sow.)	398		.	*	.	.	3	Kendal, Kirby Lonsdale, Bristol.	Liege.	*	.	
3	„ bilobatus, (Murc.)	397	xxix. 2.	*	.	.	.	1	Cara. sandstone.		*	*	*Var. compressus.*
4	„ cornu-arietis, (Sow.)	398		.	*	.	.	3	Linlithgow, Kendal.		*	.	
5	„ decussatus, (Flem.)	399	xxix. 6.	.	.	*	.	3	Linlithgow.		*	*	B. clathratus, (D'Orb.)

SYNOPTICAL TABLE.—*continued.*

No.	Genera and Species.	Reference.		Mineral character of Deposit.				Formation in which found.			Local.		Remarks.
		Page	Plate.	Slate.	Limestone.	Shale.	Sandstone.	Ireland.	Great Britain.	Foreign Locality.	Geologically.	Geographically.	
6	Bellerophon dilatatus, (Murc.)	398	xxix. 1.	*	.	.	.	1	Wenlock limest.		*	*	
7	„ *D' Orbignii,*	401	xxix. 12.	.	*	*	.	$3^{2\cdot3}$			.	.	
8	„ *elongatus,*	397	xxix. 4.	*	.	.	.	1			*	*	
9	„ *gibbus,*	398	xxix. 5.	*	.	.	.	1			*	*	
10	„ globatus, (Murc.)	568		.	.	.	*	3^{1}	Old Red.		.	.	
11	„ Hiulcus, (Sow.)	402		.	*	.	.	3^{2}	Upper Ludlow. Bolland, Derbysh. South Devon.	Nashville, U. S., Ratingen.	*	.	*Var. minor.*
12	„ *interlineatus,*	402	xxix. 11.	.	*	*	.	3^{2}			*	.	
13	„ *Larcomii,*	399	xxix. 13.	.	*	.	.	3^{2}			*	.	
14	„ *Oldhami,*	471	xxxv. 4.	.	*	*	.	$3^{2\cdot3}$			.	.	
15	„ *recticostatus,*	472	xxxv. 5.	.	*	.	.	3^{2}			*	*	
16	„ spiralis, (Ph.)	471	xxxv. 6.	.	*	.	.	3^{2}	Bowes, Yorksh.		*	*	*Var.*
17	„ striatus, (Flem.)	400	xxix. 7.	.	.	*	.	3^{3}	Glasgow.	Tournay, Paffrath.	*	*	Not B. striatus, (Ferus. Br. or Murc.) B. elegans, (D'Orb.)
18	„ tenuifascia. (Sow.)	402		.	*	.	.	3^{2}	Devon, Bolland,	Ratingen, Liege.	*	*	(Derbyshire.)
19	„ Urii, (Flem.)	400	xxix. 9.	.	.	*	.	3^{3}	Linlithgow.		*	*	
1	Belemnitella mucronata, (D'Orb.)	395		.	*	.	.	6	Chalk, Sussex, Yorkshire.	Meudon, Mæs- tricht, Dieppe, &c.	.	.	Belemnites, (Schl.) B. electrinus, (Mill.)
1	Belemnites abbreviatus, (Mil.)	139		.	.	*	.	5	Great Oolite, Yorkshire Lias,		*	.	(Scotland.)
2	„ minimus, (Lis.)	396		.	.	.	*	6^{1}	Gault, Sussex,		*	.	(Red chalk, Yorkshire.)
1	Pseudobelus striatus, (Bl.)	396		.	*	.	.	6		Valogne.	*	.	
1	Tentaculites ——?			*	.	.	.	1			*	*	
1	Ischadites ——?			*	.	.	.	1			*	*	
	GASTEROPODA.												
1	Patella Saturni, (Goldf.)	416		*	.	.	.	1		Eifel, Paffrath.	*	*	
1	Metoptoma ———?	416		*	.	.	.	1			.	.	
1	Pileopsis vetusta, (Sow.)			.	*	.	.	3^{2}	Bolland.		*	*	
1	Pileolus?			.	*	.	.	3			*	.	
1	Emarginula *cancellata,*	421		.	*	.	.	6			*	.	
1	Natica elongata, (Ph.)			.	*	.	.	3^{2}	Bolland.		*	*	
2	„ plicistria, var. α	420	xxxi. 6.	.	*	.	.	3^{2}	Bolland, Bristol.		.	.	
3	„ var. β.	421	xxxi. 7.	.	*	.	.	3^{2}	Northumberland.		*	.	
1	Nerita spirata, (Sow.)	420	xxxi. 8.	.	*	.	.	3^{2}	Bristol, Derbysh.		*	.	
1	Pleurotomaria atomaria, (Ph.)			.	.	*	.	3^{1}	Bolland.		*	.	
2	„ biserrata? (Ph.)			.	*	.	.	3^{2}	Derbyshire.		*	*	Casts; markings nearly obsolete.

3	,, cancellata, (Ph.)	.	. . .	.	*	.	.	3^2	N. & S. Devon.	. . .	*	*	
4	,, *sub-rotundata,*	414	xxx. 8.	*	.	.	.	1	. . .	. . .	*	*	
5	,, *trochiformis,*	414	xxx. 9.	*	.	.	.	1	. . .	. . .	*	*	
6	,, *turrita,*	413	xxx. 7.	*	.	.	.	1	. . .	. . .	*	*	
1	Schizostoma *latifasciatus,*	412	xxx. 4.	*	.	.	.	1	. . .	. . .	*	*	
1	Murchisonia angulata, (Ph.)	.	. . .	.	*	*	.	3^2	N. and S. Devon, Bolland.	. . .	*	.	
2	,, *elongata,*	569	xxxviii. 10.	.	.	*	.	3^1	. . .	. . .	*	.	
1	Cirrus depressus, (Sow.)	.	. . .	.	*	.	.	6	Chalk.	. . .	*	.	
2	,, pentagonalis, (Ph.)	.	. . .	.	*	.	.	3	Bolland.	. . .	*	*	
3	,, perspectivus, (Mant.)	.	. . .	.	*	.	.	6	Chalk.	. . .	*	.	
4	,, spiralis, (Ph.)	.	. . .	.	*	.	.	3^2	Bolland.	. . .	*	.	? Cirrus.
5	,, striatus, (Wood)	.	. . .	.	*	.	.	6	Chalk.	. . .	*	.	
1	Euomphalus, *Bronni,*	417	. . .	.	*	.	.	3^2	. . .	Ratingen.	*	.	Eu. pentangulatus, (Br.) not (Sow.)
2	,, catillus, (Sow.)	418	. . .	.	*	.	.	3^2	Dudley, Buxton.	Ratingen, Lake Erie.	*	*	Schizostoma cat. (Bronn.)
3	,, Dionysii, (Goldf.)	417	. . .	.	*	.	.	3^2	Yorkshire.	Namur, Ratingen.	.	.	Cirrus rotundatus, (Sow.) Helicites Dion. (Schl.)
4	,, granulatus, (Müns.)	410	xxx. 5.	*	.	.	.	1	. . .	Schübelhammer, Gattendorf.	*	*	In "Clymenienkalk."
5	,, *lineatus,*	410	xxx. 6.	*	.	.	.	1	. . .	. . .	*	*	
6	,, *parvus,*	411	xxx. 1.	*	.	.	.	1	. . .	. . .	*	*	
7	,, pentangulatus, (Sow.)	416	. . .	.	*	.	.	3^2	Bolland.	. . .	*	.	
8	,, perturbatus, (Murc.)	.	. . .	*	.	.	.	1	Llandeilo flags.	. . .	*	*	
9	,, sculptus, (Murc.)	410	xxx. 2.	*	.	.	.	1	Wen. limestone.	. . .	*	.	
10	,, sub-sulcatus, (His.)	409	xxx. 3.	*	.	.	.	1	. . .	Gottland.	*	*	
11	,, tuberculatus,	417	. . .	.	*	.	.	3^2	West Lothian.	. . .	*	.	Delphinula tuberculata, (Flem.)
1	*Ecculiomphalus Bucklandi,*	411	xxx. 10.	*	.	.	.	1	. . .	. . .	*	*	
2	,, *minor,*	412	xxx. 11, 12.	*	.	.	.	1	. . .	. . .	*	*	
1	Melania Bronni, (Roe.)	123	. . .	.	.	.	*	5	. . .	. . .	.	.	
1	Trochus anglicus, (Sow.)	123	. . .	.	.	*	.	5	Lias.	. . .	*	.	
2	,, ellipticus, (His.)	414	xxxi. 1.	*	.	.	.	1	. . .	Tran. lime, Furudal	*	*	
3	,, fasciatus ? (Sow.)	123	. . .	.	.	*	.	5	Lias.	. . .	*	.	
4	,, helicites, (Murc.)	.	. . .	.	.	*	.	3^3	Old Red, Upper Ludlow.	. . .	*	*	
5	,, regalis, (Roe.)	.	. . .	.	*	.	.	6	. . .	Low. chalk, Ilseburg.	*	.	
6	,, Usocona, (Sow.)	.	. . .	.	.	*	.	3	Coalbrookdale.	. . .	*	*	
1	Turbo bicarinatus (Sow.)	421	. . .	.	*	.	.	6	. . .	. . .	*	.	(Sow.) MSS.
2	,, *appropinquans,*	746	xxxviii. 11.	.	*	.	.	3	. . .	. . .	*	.	
1	Turritella *percincta,*	123	. . .	.	.	.	*	5	. . .	. . .	*	.	
2	,, *sulcifera,*	420	xxxi. 11.	.	.	*	.	3	. . .	. . .	*	.	
3	,, *tenuicostata,*	124	. . .	.	.	*	.	5	. . .	. . .	*	*	
1	Cerithium carbonarium, (Goldf.)	124	. . .	.	.	.	*	5	. . .	Minden.	*	.	"Hautes Alpes."
2	,, unicarinatum, (Wood.)	421	. . .	.	*	.	.	6	Chalk.	. . .	*	.	
1	Pyrula ?	.	. . .	.	*	.	.	6	. . .	. . .	.	.	In form resembles P. coronata, (Roe.) costæ 4 times as distant.
2	,, *rapulum,* (Sow.)	421	. . .	.	*	.	.	6	. . .	. . .	*	*	(Sow.) MSS.
1	Rostellaria elongata, (Roe.)	.	. . .	.	*	.	.	6	. . .	Chalk marl, Aachen.	*	*	? Pleurotoma remote lineata, (Gei.)
2	,, ? turrilitellata, (D. Ar.)	.	. . .	.	*	.	.	6	. . .	Saintes.	*	*	Turbo tur. (D'Ar.)
1	Cassis avellana, (Brong.)	421	. . .	.	*	.	.	6	. . .	Paris.	*	.	

SYNOPTICAL TABLE.—*continued.*

No.	Genera and Species.	Reference.		Mineral character of Deposit.				Formation in which found.			Local.		Remarks.
		Page	Plate.	Slate.	Limestone.	Shale.	Sandstone.	Ireland.	Great Britain.	Foreign Locality.	Geologically.	Geographically.	
1	Macrocheilus imbricatus, (Ph.)	419	xxxi. 9.	.	*	.	.	3	Bolland, Isle of Man.	. . .	.	.	Buccinum imb. (Sow.) (Ph.)
2	,, *percinctus,*	419	xxxi. 10.	.	*	.	.	3	. . .	. . .	*	*	
1	Loxonema *obscura,*	415	xxxi. 3.	*	.	.	.	1	. . .	. . .	*	*	
2	,, *tenui-striata,*	418	xxxi. 4.	.	.	*	.	3	. . .	. . .	*	.	
1	Buccinum parallele, (Ph.)	.	. . .	.	*	.	.	3	Bolland.	. . .	*	*	
1	*Polyphemopsis* elongatus,	416	xxxi. 2.	*	.	.	.	1	. . .	. . .	*	*	
	PISCES.												
1	Palæoniscus catopterus, (Ag.)	468	. . .	.	.	.	*	4	. . .	. . .	*	*	
2	,, Egertoni ? (Ag.)	463	xiv. 1.	.	.	*	.	3	. . .	. . .	*	*	
3	,, Robisoni ? (Hib.)	462	xiv. A. 13, 15.	.	.	*	.	3	Burdie House.	. . .	*	*	
1	Amblypterus —— ?	462	xiv. A. 14.	.	.	*	.	3^1	. . .	. . .	*	*	
1	Gyrolepis Albertii, (Ag.)	469	xiv. 12, 13, 14.	.	.	.	*	?4	Axmouth, Austcliff.	Muschelkalk.	.	.	Swenningen, Luneville.
2	,, tenui-striatus, (Ag.)	469	xiv. 11.	.	.	.	*	?4	Axmouth. Austcliff.	Muschelkalk.	.	.	Luneville.
1	Cephalaspis —— ?	468	xiv. A. 11.	.	.	*	.	3^1	. . .	. . .	.	.	
1	Psammodus cornutus, (Ag.)	466	xiv. A. 3.	.	*	*	.	3^2	. . .	. . .	.	.	
2	,, porosus, (Ag.)	465	xiv. A. 1.	.	*	.	.	3^2	Bristol.	. . .	.	.	
3	,, rugosus, (Ag.)	466	. . .	.	*	.	.	3^2	Bristol.	? Eifel.	.	.	Also from Sligo.
1	Helodus didymus, (Ag.)	461	. . .	.	*	.	.	3^2	. . .	. . .	*	*	
2	,, lævissimus, (Ag.)	461	. . .	.	*	.	.	3^2	Bristol.	. . .	*	*	Psammodus, (Egerton.)
3	,, mammillaris, (Ag.)	461	. . .	.	*	.	.	3^2	. . .	. . .	*	*	
4	,, planus, (Ag.)	461	. . .	.	*	.	.	3^2	. . .	. . .	*	*	
5	,, turgidus, (Ag.)	461 473	. . .	.	*	.	.	3^2	Bristol.	. . .	*	.	Psammodus, (Ag.) (Eg.)
1	Chomatodus cinctus, (Ag.)	467	xiv. A. 9.	.	*	.	.	3^2	Bristol.	. . .	*	*	Psammodus, (Ag.) (Eg.)
2	,, linearis, (Ag.)	466	xiv. 8.	.	*	.	.	3^2	Bristol.	. . .	*	.	
3	,, truncatus, (Ag.)	461	. . .	.	*	.	.	3^2	. . .	. . .	*	*	
4	,, —— ?	461	. . .	.	*	.	.	3^2	. . .	. . .	.	*	
1	Cochliodus acutus, (Ag.)	466	. . .	.	*	.	.	3^2	. . .	. . .	*	.	
2	,, contortus, (Ag.)	466	. . .	.	*	.	.	3^2	Clifton, Bristol.	. . .	*	*	Psammodus con. (Ag.)
3	,, magnus, (Ag.)	466	xiv. A. 4.	.	*	.	.	3^2	. . .	. . .	*	.	
4	,, oblongus, (Ag.)	466	xiv. A. 5, 10	.	*	.	.	3^2	. . .	. . .	*	*	
5	,, striatus, (Ag.)	461	. . .	.	*	.	.	3^2	. . .	. . .	*	*	
1	Cladodus acutus, (Ag.)	461	. . .	.	*	.	.	5^2	. . .	. . .	*	*	
2	,, basalis, (Ag.)	461	. . .	.	*	.	.	3^2	. . .	. . .	*	*	
3	,, marginalis, (Ag.)	461	. . .	.	*	.	.	3^2	. . .	. . .	*	*	

4	,, mirabilis, (Ag.)	461		.	*	.	.	3²			*	*	
5	,, striatus, (Ag.)	461		.	*	.	.	3²			*	*	
1	Ctenoptychius macrodus, (Ag.)	467	xiv. 7.	.	*	.	.	3²			*	.	Petalodus dentatus, (Ow.)
2	,, marginalis,	461		.	*	.	.	3²			*	*	
3	,, radicans, (Ag.)	461		.	*	.	.	3²			*	*	
4	,, serratus, (Ag.)	461		.	*	.	.	3²			*	*	
1	Petalodus Hastingsii, (Ag.)	468	xiv. 10.	.	*	.	.	3²			*	.	
2	,, lævissimus, (Ag.)	461		.	*	.	.	3²			*	*	
3	,, psittaceus, (Ag.)	461		.	*	.	.	3²			*	*	
4	,, rectus, (Ag.)	468	xiv. 9.	.	*	.	.	3²			*	.	
5	,, sagittatus, (Ag.)	461		.	*	.	.	3²			*	*	
1	Orodus angustus, (Ag.)	461		.	*	.	.	3²			*	*	
2	,, catenatus, (Ag.)	461		.	*	.	.	3²			*	*	
3	,, gibbus, (Ag.)	461		.	*	.	.	3²			*	*	
4	,, ramosus, (Ag.)	467	xiv. A. 8.	.	*	.	.	3	Bristol.		*	*	Hook Point, Wexford.
1	Acrodus minimus, (Ag.)	469	xiv. 18.	.	.	.	.	?4	Aust Cliff, Lyme Regis.		*	*	My own impression of these species is, that A. minimus is A. Althausii, and the second is A. minimus.
2	,, ———?	469	xiv. 17.	.	.	.	.	?4			.	.	
1	Ctenacanthus arcuatus, (Ag.)	461		.	*	.	.	3²			.	.	
2	,, crenulatus, (Ag.)	461		.	*	.	.	3²			*	*	
3	,, heterogyrus, (Ag.)	461		.	*	.	.	3²			*	*	
1	Asteroptychius ornatus, (Ag.)	461		.	*	.	.	3²			*	*	New genus.
1	Leptacanthus priscus, (Ag.)	461		.	*	.	.	3²			*	*	
1	Oracanthus confluens, (Ag.)	461		.	*	.	.	3²	Bristol.		*	*	
2	,, minor, (Ag.)	461		.	*	.	.	3²			*	*	
1	Ptysonemus subteres, (Ag.)	461		.	*	.	.	3²			*	*	New genus.
1	Onchus falcatus, (Ag.)	461		.	*	.	.	3²			*	*	
2	,, plicatus, (Ag.)	461		.	*	.	.	3²			*	*	
3	,, rectus, (Ag.)	461		.	*	.	.	3²			*	*	
1	Pæcilodus Jonesii, (Ag.)	468	xiv. A. 6.	.	*	.	.	3²			*	*	
2	,, obliquus, (Ag.)	461		.	*	.	.	3²			*	*	
3	,, parallelis, (Ag.)	461		.	*	.	.	3²			*	*	
4	,, sublævis, (Ag.)	461		.	*	.	.	3²			*	*	
5	,, transversus, (Ag.)	468	xiv. A. 7.	.	*	.	.	3²			*	*	
1	Gyracanthus formosus, (Ag.)	463		.	.	*	.		Dudley, Alnwick, Sunderland, Burdie House.		*	*	(North Wales.)
2	,, tuberculatus, (Ag.)	463	xiii. 14, 15.	.	.	*	.	3¹	Sunderland, Burdie House.		*	*	
1	Oxyrhina ———?	470		.	*	.	.	6			.	.	
1	Lamna elegans ? (Ag.)	470		.	.	.	*	6			.	.	
2	,, ———?	139		.	*	.	.	6			.	.	
1	Chimera ———?			.	*	.	.	6			*	*	
1	Hemipristis ———? (Ag.)	470		.	*	.	.	6			.	.	
1	Megalicthys Hibbertii, (Ag.)	464	xiv. A. 12.	.	.	*	.	3¹	Burdie House,		*	*	(Berwick.)
1	Holoptychius Hibbertii, (Ag.)	464		.	.	*	.	3¹	Burdie House.		*	.	
2	,, Portlockii, (Ag.)	464	xiii.	.	.	*	.	3¹			*	.	
3	,, ———?	473	xiv. 2.	.	.	*	.	3³			*	*	
1	Tristychius *minor*,	464	xiv. 6.	.	.	*	.	3³			*	*	
1	Sauricthys apicalis, (Ag.)	470	xiv. 19.	.	*	.	.	?4	Axmouth.	Bayreuth.	*	*	
1	Coprolite ———?	470	xiv. 10.	.	*	.	.	?4			*	*	

In the preceding table, the Gasteropoda should have preceded the Cephalopoda.

The total number of fossils noticed in the table, may be thus enumerated:—

Silurian . . .	216	Poikilitic, upper, or Trias	5
Carboniferous . .	325	Oolitic, principally Liasic	96
Poikilitic, lower . .	2	Cretaceous . . .	81
General total . . .	725		

In respect to deductions to be drawn from the table, it may be remarked that a summary of the silurian fossils has been given at page 476; the fossils of that formation having, perhaps, been referred with more precision, in the work of Mr. Murchison, to their respective sub-divisions, than in any other of the British strata. Of a Devonian system, there are only very obsure traces in this district; and the fragments of the cephalothoracic margin of a Trinucleus, found in the Kildress red grits, has not been deemed sufficient to introduce that genus as occurring beyond the limits of their natural habitat in the silurian strata. In the carboniferous strata, some additions of British species have been made even to the copious list of Mr. Griffith; and in a similar manner, by the identification of the Berwick fossils with the Sanguinolaria *transversa* and S. *undata* of this Report, other proofs are afforded of the striking accordance of the system taken as a whole in Scotland, England, and Ireland. One of the most curious and interesting facts which the examination of this district has established, and the table points out, is the very limited lateral range of many of the fossils: this fact has a most important bearing on geological reasonings and deductions, as it is quite evident that very different results would be arrived at by comparing the places where the beds containing these fossils are with those where they are not; but at the same time it might be hoped to find, on extended examination, other localities, similarly isolated, of the same fossils, and they would then become still more decided marks of geological epochs. The true method of comparing fossils appears to be by groups, as the collocation together of the same fossils, indicates at once similar physical and geological conditions. Several of these groups have been noticed in Chapter XII., and will doubtless hereafter assist, when brought into comparison with other examples of the same grouping in less ambiguous positions, to subdivide the formation; one of them is that afforded by the curious shale deposit of Sheets 17 and 18 in Fermanagh (page 594), where scales of Holoptychius *Portlockii* and of a Palæoniscus are associated with Orthis *orbicularis*, O. *pulchra*, Lingula *squamiformis*, and Pterinea *Thomsoni*, a group which is remarkably distinct from any as yet noticed in the district, and one which, if hereafter discovered in a definite section, will serve as a most satisfactory clue to the geology of the district. On the whole it may be said of the carboniferous fossils, that as in this limited district some of the species supposed to be peculiar to England have been found, so also it may be assumed that more rigid research in England and Scotland would discover many of those now considered peculiar to Ireland. At the same time the occurrence of local groups is quite consistent with the known geographical distribution of living animals, and, taken alone, is no proof of a difference of epoch. In the trias, several of the most striking species have been noted. In the lias, many very characteristic species have been recorded, and it is highly probable that the formation has a more extended vertical range than the liasic or lower subdivision of the oolites; but for the reasons already stated, it would be useless to attempt a subdivision in a district where the strata are all, as it were, fragments, disturbed and thrown out of their position by slips. In the cretaceous strata, three divisions can be distinctly recognised, and so far as possible the fossils have been marked to indicate them: first, the arenaceous or greensand, in which it is highly probable that several minor subdivisions corresponding to those of England may be hereafter satisfactorily established from a comparison of the formation in Antrim with that of Derry. 2nd. The chalk marls corresponding to the lower chalk, rich in fossils, but of small vertical thickness. 3rd. The white chalk, or chalk with flints, which is the upper division, and most highly developed. To form, then, summaries from the table in either of these formations is a simple operation which may be safely left to the reader.

N. B.—The geological figure of Orthoceras *sub-imbricatum*, page 763, should have been ? 3, and that of Cladodus *acutus*, page 768, 3^2.

INDEX.

Actynolite, small quantity of, found, and where, 210; varieties of, 211.

Aghanloo, County of Derry, 100, 104, 108: coal at, 47.

Agriculture. Influence of physical features of the country, upon climate, and its importance to agriculturists, &c., 89, 649. Statement on climate and drainage, 649—669. Injurious effects of absence of efficient drainage, 652, 653, 655: and advantages of good drainage, 654, 656. Tables showing improvements made in certain estates by drainage, fencing, liming, &c., 657. Provisions in leases, and means of effecting improvements, 658, 660. Cost of improvements, 655, 656, 657: tables, 668, 669. Effects of dampness of climate in regard to, 649, 652. State of agricultural population, 653. Means of improvement in, 656. Number and extent of farms in Derry, and management of, in respect to draining, 660. Statement on cultivation, 690—709. General account of state of agricultural districts and population of the north, 690. Size of farms, 691. System of cultivation by small farmers, 691. Rotation of crops, 692. Tables of sizes of farms, 693: of rotations of crops, 694: of proportions of crops, 696: of average cost per acre of cultivation of the various crops, 698. Modes of improvement, and influence of the London companies in respect to it, 699, 708. Live stock, 699, 700. Manufacture of cheese, 700. Associations in France for cheese-making, 701. Orchards, 709. Agricultural schools, paper on the establishment of, 710. Account of Templemoyle agricultural school, its management, rules, &c. 710. Horticultural schools, desirableness of, 734.

Albite, account of, and localities where found, 212.

Altmover Glen, near Dungiven; description of formations at, 576.

Alumina, sulphate of, state and localities in which found, 213.

Aluminite, localities where found, 213.

Amber, description of, and localities where found, 227.

Analcime, varieties and description of, and localities where found, 220.

Annagher Colliery: account of, 599 *et seq.*

Annaghone coal pits, account of, 70, 629.

Anthologia Hibernica, 1794, on geology of Derry, 23.

Antrim, Rev. William Hamilton's Letter on the northern coast of, 30: geologica description thereof, 32: extensive chalky limestone range, 33. Rev. Dr. Richardson on geological alterations in, 34—44. Rev. William Conybeare on diluvial action in, 36, 40. Rev. W. Bukland's observations, 40. Dr. Berger and Mr. Conybeare, on geology of, 50. Mr. Griffith's survey of coal districts of, 59. Mr. Bryce on the north-eastern part of, 78.

Antrimolite, description of, and localities where found, 218.

Apjohn, Dr. Observations and analysis of mineral substance found at Tamlaght, 115: comparison of this substance with basalt, 117. Analysis of flint also found, 117. Analysis of Drumrankin ochre, 173, 174. Tables of weather in various years in Dublin, contributed by, 665.

Apophyllite, description of, and localities where found, 223.

Aqueous Agencies. Views of ancient authors on the action and changes of the sea, 4. Supposed effects of diluvial action, and erroneous opinions thereon, 24—26, 37: as to origin of basaltic formations, 37—39. Supposed arguments in support of, 37, 40. Examples of the action of the sea in the wear of rocks, 95, 102, 103. Aqueous action and subsidence as shown in landslips, 103, 104, 109.

Arigna iron works, 72.

Armagh; unsuccessful sinking for coal at Gorestown, 27. Dr. Berger and Mr. Conybeare on geology of, 50.

Arragonite, account of, and localities where found, 213.

Artrea, greenstone dyke, 116, 741.

Asbestus, where found, 210.

Augite, description of, and localities where found, 210.

Authors on geology of the district. Review of the works of preceding writers, 22—82. Views of early writers on crustacea, 235.

Ballintoy, limestone, lias, and chalk, &c., 33, 34, 40, 41, 43, 54, 56, 58, 92, 98, 99, 100, 102, *et passim.*

Ballycastle, 80, 91, 92, 102: basalt and fragments of lava at, 28. Limestone formations at, 33, 34, 54. Collieries, Carrick Mawr Dyke, 41, 54.

Ballycastle Orchard, shell bank at; the Giant's Grave, 24.

Bartley coal pits, account of, 609.

Barton, Lectures on Natural History of Lough Neagh, 74.

Barytes, sulphate of, character and prevalence of, 215. Frequent occurrence of, in metamorphic rocks, 514: in sandstones, 525: and similar rocks, 528.

Basalt. Colour representing, green, 20. Letter designating deposit of, T., 21. Accounts of basaltic formations about Coleraine, the Causeway, &c., 27—32. Alterations in basaltic structures in Derry and Antrim, 34. Erroneous views as to aqueous origin of basaltic formations, 37—39. Position of basalts in Ireland, in regard to secondary strata, that of overlying rocks, 42. Relation of beds of ochre to, 31, 32, 35, 44. Connection of, with greenstone, 57. Connection of, with silicified woods, 76. Strata underlying the basalt, from chalk to new red sandstone, account of, 90—118: enumeration of fossils found in lias formation, 118—140. Isolated masses of, imbedded in chalk, 93, 94: speculations thereon, 147. Basalt of Portrush and Down Hill, 101. Beds of basalt and ochre of Benyevenagh, 103. Account of basalt and chalk formations, 110. Connection of, with the chalk formations, 149. Evidences of the result of their contact, 116. General review of the extent and course of the great western basaltic formation, 141, 149. Constitution of the basaltic masses described, and sections from different places given, 141—145. Deductions as to the character, origin, and changes of basaltic beds, 145, 146. Illustrations of, 147, 148. Character of the basaltic flows, 146. Alternations of prismatic and massive basalt, 146, 147. Detailed examination of the varieties and mineral structure of the basalt, as compared with the augite rock and lias of Portrush, 150. Basaltic and non-basaltic dykes, 155. Basaltic formations connected with the sandstones, 483. Basaltic dykes in other formations, 529. Descriptive table of quarries, showing localities, application, value, &c. 673—675.

Beaumont, M. Elie de. New red sandstone described by, 6.

Belfast, extensive chalky limestone range, 33, 87—89, 107. On tertiary deposit of marine shells near, 738.

Belfast Lough, deposition of shells in, 27.

Benbradagh, 53, 55, 111, 114. Benbradagh to Eden, geology of, 111.

Bengore, capes and bays of; account of, 32: basalts at Bengore promontory, 33. Dr. Richardson's description of, 35, 45.

Benyevenagh, undercliff of, and view, 26, 34, 55. Descriptive account of, 102—109: and cuts of, 103, 104, 110. Section of basalt, &c., 143.

Beresford, J. B., Esq. on improved system for effecting drainage, 656.

Berger, Dr., on the geology of the north-eastern counties of Ireland, and Rev. W. Conybeare's remarks, 50 *et seq.*

Bitter spar, or brown spar, account of, and localities where found, 214.

Blackwater river, geological features of, 52, 61.

Blue colour, representing limestone, 20.

Boate, Dr., on Lough Neagh, 75.

Bog, alternating with sand, about Lough Foyle, &c., and shells therein, 161. Sand and clay deposits connected with, and wood, &c. found therein, by Lough Beg, 161. Submarine peat used with advantage as manure, 166: account of, in Carnarvonshire, and use of, 166.

Bole, character of, and localities where found, 210.

Botany, variety and richness of Magilligan parish (Derry,) as a botanical region, 23.

Boulders. See under *Detritus.* Chapter on detritus; account and description of boulders therein, 630—640. Agencies by which deposited, localities, elevations, &c., 630, 631, 640.

Brachiopoda, account of, in silurian strata, 447, *et seq.*

Brewsterite, said to occur at the Causeway 223.

Brongniart, on fossils, 237.

Bronn, on crustacea, 239.

Bronzite, how and where found, 211: and character and analysis of, 742.

Brooke, Mr., on minerals, 220, 221.

Brown colours, representing shales and clay, and slates, 20.

Bruckenman's discoveries in basalt of France, 38.

Bryce, Mr. James, of Belfast, on mica schists and red sandstones of Cushendall, 19: account of Portrush rock, 41: Mr. Griffith's remarks thereon, 43. On the north-eastern part of County Antrim, 78, 97. On tertiary deposit of marine shells, near Belfast, 738.

Buckland, Rev. Dr., quoted, 93, 94, 98, &c., on silurian fossils, 239. Dr. Buckland and Rev. W. Conybeare, observations of, in Antrim (1813), 40. On Derry, &c., 51. Antrim and Derry, 58.

Burnthollet, ancient river course; woodcuts, 176, 177.

Calcareous beds, alternating with shales; account of, 574, 575; with limestones, sandstones, &c., 582. Chalk pebbles in calcareous clays, 159.

Calcedony, varieties of, and localities where found, 208, 209.

Cape Pleaskin, description of, and successive formations, 31.

Carbonate of iron, description and varieties of, and localities where found, 226.

Carboniferous strata. Descriptive list and detailed account of fossils in, and in silurian and cretaceous strata, 306 *et seq.* Indications of, connected with sandstone formations, 482, 503, &c. Chapter describing the carboniferous strata, 560—629. Course of examination and peculiarities of condition of, 560 *et seq.* Difficulty of determining the geological sequence and divisions of, 563. Fossils found in, 564, 573, 576, 745. Resemblance of, to strata in Scotland, 564. Deposits and succession of beds described, and fossils therein, 566, 567, 568, 574, 575. Epochs of formations, 572, 574. Variations in typical character of lower section of, 578. Account of second section of, beginning with limestones, 578; succession of beds, 579.

Carnowry, Rockhead, section of basalt, &c. 142.

Carrickfergus bay, (the Whitehead); extensive chalky limestone range, 33.

Carrick Mawr Dyke, (Ballycastle Collieries,) 41.

Caves. Chalk caves, Piper's Cave, 102. Stalactites in, 103.

Cephalopoda, in the silurian strata, &c., 364.

Chabazite, varieties and description of, and localities where found, 219.

Chalilite, varieties and description of, and localities where found, 218.

Chalk. Account of the extensive chalk district on the coast of Antrim, from Carrickfergus to Lough Foyle, 32, 33. Character of formations of, 56; and of its connection with the basalt, 116, 149. Account of, and of other strata underlying the basalt, to new red sandstone, 90, 118. Enumeration of fossils found in lias formation, 118—140. Description of course and character of chalk formations, 92 *et seq.*: in connection with sandstone formations, 500. Ochre imbedded in chalk, at Ballintoy, 92. Isolated masses of basalt imbedded in, 93, 94: speculations thereon, 147. Dip of strata inwards, and transverse fissures in; irregularity of, represented by woodcut, 95. Dip, &c. of, 98, 102. Variety and beauty of the chalk cliffs of Portrush and Dunluce, 96. Granular vesicular beds in, lined with crystals of carbonate of lime and quartz, 111. Chemical effects of contact, 112, 113. Clayey substance discovered; analysis of it, 115, 117. Phenomena exhibited of chemical change and mechanical action, 116. Chalk pebbles in calcareous clays, 159.

Changes in the secondary strata and overlying trap rocks, 91, 92. Evidences of change in rocks, 99, 102. (See *Metamorphosis.*)

Charcoal, mineral; where found, 226.

Cheese: rural associations for manufacture of, their plan and operations, 701.

Chert, account of, and localities where found, 208.

Chlorite, how and where found, 212. Green earth, 212.

Chlorophæite, description of, and localities where found, 227.

Chrysolite, localities where found, 211.

Clay, colour for representing clay and shales, brown, 20; letter representing deposit of, C., 21. Clays in connection with sandstone and oolitic systems, Benyevenagh, 107. Account of calcareous clay formations, 157. Descriptions of clays, and strata in contact with them, in Derry, &c., 158. Shells in, 157, 158. Account of chalk pebbles, flint, &c., in, 159. Brick clay, and alternation with other clays, 160. Bluish and white clay underlying bog, near Lough Beg; wood, &c., therein, 161. Origin of clays and sands of Lough Neagh and Lough Beg, prove the lakes to have been formerly of higher level, 165; character of these beds, 165. Clay slates in Donegal, 170. Clay slates in schistose formations; character and analysis of, 178, 179, 183. Uses of, and localities where found; potteries, 680. Cost and working of, 681. Descriptive table of kilns, their localities, produce, cost, &c., 683, 684: potteries, 684.

Climate: influence of turf burning upon, by causing rain and wind, 23. Influence of physical features of the country upon, and importance of, to agriculturists, &c., 89, 649. Remarks on climate and drainage, 649—669. Effects of wet climate, 653. Observations of the weather, and returns furnished by Mr. Wilkinson, 89, 649. Tables of the states of the weather, evidencing the popular impressions of it, 650, 662. &c. Comparative quantities of rain in London and Dublin, 650, 651, 663. Tables of temperature and rain at Belfast, for six years, 664; the same for Dublin, by Dr. Apjohn, 665. Comparison of rain in different months, and advantage of draining accordingly, 652. See *Drainage.* Tables classifying returns of weather according to months, London and Dublin, for various years, 666—668. See *Agriculture.*

Coagh (Co. Tyrone), 114: extensive chalky limestone range, 33.

Coal: attempts in search of, Armagh, Tyrone, &c., 27, 28. Mr. Griffith's survey of coal districts in Antrim and Tyrone, 59: Dungiven, 47: at Magilligan, and Ballycarton, 48. Tircreven Burn, 108. Coal in Derry and Antrim, 54. Coal series, 60, 71, 72. Representation of, in Griffith's map, 68. Coal formation of Derry, 80. Borings for coal in Tyrone, and beds passed through, 28, 167. Description of the strata connected with and bored through in the coal formations of

Tyrone, 600, 601, 610—612, 614—619. Difference in thickness and composition, 609. Description of, in various coal fields, 226. Descriptive account of the collieries of the County of Tyrone, 599—629. Account by Mr. Griffith of Annagher Colliery, 599: mode of working, 604: establishments for working, defective, 607. Account by Mr. Sinclair, of Bartley pits, 609; and of Drumglass collieries, 613. Mode of working, 620, 624. Excellence of establishments, 624, 626. Capability of augmenting the sale of coal, 608, 626. Relation of various seams to one another, 627. Fossil remains in, 602, 627. Account of Annaghone and Templereagh pits, 629. Applications of capital and power consequent on the proximity of, 685. See *Collieries.*

Coal Island, Tyrone, 54, 55, 68. Account of Coal Island collieries, 599 *et seq.*

Coleraine, 87—89; basalt and fragments of lava near, 28.

Collieries: Carrick Mawr Dyke, 41, 54. Descriptive account of the collieries in the County of Tyrone, 599—629. Account, by Mr. Griffith, of Annagher Colliery, 599. Account by Mr. Sinclair, of Bartley pits, 609; and of Drumglass collieries, 28, 613. Produce of, cost and prices, &c., 604, 623, 626. Ages and wages of workpeople, 622. Account of Annaghone and Templereagh pits, 629. Account of strata bored through in Tyrone collieries, 28, 600, 610, 611, 614, 616, 618: in Drumglass collieries, 616, 617. See *Coal.*

Colours for representing geological formations as compared with other signs, 8. Principles upon which the system of colours and signs adopted has been founded, 8—20. Colours and signs explained, 20, 21. Difficulty of designating geological formations by colours alone. 478.

Commerce. See *Coal*, *Economic Geology*, *Quarries*, *&c.* Influence of geological features on commercial prosperity, 87. Markets, imports and exports, &c., 88. Products, 89. Advantageous locality for establishing trade in sulphur, 685, 686. See *Pyrites.*

Conglomerates. Conglomeritic structures near Ballycastle, 91. Trap, flint, and chalk conglomerated; Portrush, 93, 101, 102. Donald's Hill, 111. Alternating with the schists in the silurian district, 232. Amongst the sandstone formations, 488, 492, 493, 496, 501, &c. Amongst carboniferous strata, 571, 573, 574. Old red sandstone conglomerate and beds connected with it; fossils therein, 571. Formed by consolidation of gravel, &c., with calcareous matter, 635.

Connaught coal district, 71.

Conybeare, Rev. W., on diluvial action in County Antrim, 36. Observations of, and of Rev. W. Buckland, 40, 58. Remarks on the geology of the north-eastern counties of Ireland, 50.

Copper lode, near Cappagh Mountain; extent and direction of, 493.

Copper pyrites, where found, 226. Sulphuret of copper: vitreous copper, 745.

Corals, in the silurian and carboniferous systems, 336, 338, 340.

Cornelian, localities where found, 209.

Cotta, on granites, syenites, and sandstone, 520.

Craigahulliar, basaltic columns; description and woodcut, 147.

Cretaceous fossils described, 340 *et seq.*

Crustacea, account of fossils of this class, in the silurian strata, 234. Views of early writers upon, 235. Nomenclature and detailed descriptive lists of, in the silurian and carboniferous strata, &c., 249, 254, 304, 340. Geological distribution of, in the different strata, and classification, 317.

Crystal, rock, description of specimens of, and localities where found, 207.

Crystalline schists: distinctive colour given to, expressive of metamorphic condition, 19. Account of crystalline schists, gneiss, mica schist, hornblendic schist, 168—204. Anterior to the secondary strata, 168. Course and dip of the strata, 169.

Cultivation. See *Agriculture.*

Cushendall; mica schists and red sandstones of, 54: considered as being associated together, 19. Porphyry, 77, 80.

Cyathophyllum, in the silurian and carboniferous strata, 328.

Dalman, on silurian fossils, 238 *et seq.*

De la Beche. Mode of colouring geological formations, in maps, adopted by, 9. On the physical features of a country, 83.

Deposits, mode of designating in Map, by letters, &c., and order of deposits by figures, explained, 21.

Desertcreat, 64, 229, *et passim.*

Desertmartin, 47, 48, 54, 70, *et passim.*

Detritus. Notices of detritic deposits, 49: chapter on, 630—640. Detritic features of the country, 84, 85. Descriptions of, 630; and characters of sand, gravel, boulders, &c., 631 *et seq.* Agencies by which deposited, and mode of operation, 630, 631, 638. Boulders, 631, 640. Gravel and sand, 632, 633, 636. Arrangement and regularity in detritic beds, 633, 638. Consolidation of beds by calcareous matter, 635. Epochs of formation, 630, 635. Deposits of, at great elevations, 637, 640.

Diluvial action and effects, speculations thereon, 24, 26, 27, 37, 40. Views opposed thereto, 36. See *Aqueous Agencies.*

Dolomieu, a supporter of volcanic theory, 37.

Donald's Hill, 55, 56, 102. Geology of tract from, to Keady, 110.

Donegal. Archbishop King's paper on the geology of Donegal and Derry (1708,) 22.
Doranite, a zeolitic mineral; locality, character, and analysis of, 745.
Down, County of. Extensive chalky limestone range, 33. Dr. Berger and Mr. Conybeare on geology of, 50.
Down Hill, 101, 102. Section of basalt, 142.
Drainage, necessity and importance of, in damp climates, 652. See *Climate*. Value of, in reference to the comparative amount of rain in different months, 652. Injurious effects from want of efficient drainage, in an economic point of view, and in regard to the health and habits of the people, 652, 653, 655. Peculiar necessity of, in Ireland, 653: and advantages of good drainage, 654, 656. Table, showing improvements made in some estates by, &c., 657. Provision for, in leases, and means of effecting improvements, 658, 660. Cost of, 655—657. Tables of cost of, with loose stones, and with tiles, &c., 668, 669.
Drumglass Colliery (Tyrone); account of, 613: one seam only of coal found, (1786,) 28. Strata bored through at Drumglass collieries, 616, 647.
Dubourdieu, Rev. T., Survey of Antrim, (1812), 40.
Dungannon, 54, 60, 62, 65, 69, 70. Deposit of shell marl near, 740.
Dungiven, (County Derry). Geological appearances of, 5, (Plate A. fig. 4.) 55, 86, 87. Extensive chalky limestone range, 33. Coal, 47. Blue limestone, 48, 111.
Dunluce Castle; white limestone at, resemblance to chalk, 28. Depression of chalky cliffs at, and at Dunluce, 33, 40. White Rocks, 92, 93, 98, 116.
Dykes, of regular basaltic formations, and of non-basaltic formations, 155: at Lady O'Cahan's Bridge, 506. Of crystalline greenstone, in conglomerates and sandstone formations, 495, 496. Greenstone dykes, intersecting sandstones, shown by Map, 506, 741. Formation of, 507. Carrick Mawr Dyke (Ballycastle collieries), 41. Trap dykes, 507, 523. Effects produced by, physical and chemical, stated, 509. Descriptive account of, and instances of greenstone dykes, 510, 511. Of trap dykes, 523, &c. Basaltic dykes connected with other formations, 529. Greenstone dyke, Artrea, 741.

Echinida, where found, and description of, 351.
Economic geology, statement on, 641 *et seq*. Mineral springs, 641. Climate and drainage, 649. Mineral statistics, 670. Soils, 688. Cultivation, 690 Agricultural schools, 710; and horticultural schools, 734.
Edwards, Milne, on silurian fossils, 239, 253.
Egebergs: junction of limestone and granite formations, near, 15.
Eights, James, on Trilobites, (South Shetland,) 240.
Epidote, description of, and localities where found, 209, 210.
Epochs of geological change, and means of judging of them, 5, 6. Relation between epochs of mineral and organic change, 6. Geological epochs enumerated, and distinguished by signs and numbers in Map; explanation thereof, 21. Indications of successive depositions or eruptions, relation of basaltic and ochre formations, &c., 45. Ages of sandstones, 54: of schists, 168: of silurian deposits, 232. Epochs of formation of porphyritic rocks, 530. Of phenomena of igneous and metamorphic rocks, 557. Of formation of carboniferous strata, 572, 574, 578: of detritic deposits, 630, 635.
Erinite, where found, 221.
Eruptions. See *Volcanic Action*.
Espy, Mr. Theory of storms; anticipation of, by Archbishop King, 23.
Everest, Rev. Robert: account of change of carbonaceous shales into mica schist, in Himalaya Mountains, 18.

Fairhead, 33, 34, 57, 58, 91, 97, &c.
Felspar, description of, and localities where found, 212.
Finger-stone, or Merog (Lough Foyle); description and view of the rock, 25.
Fishes, strata in which found, 460. Descriptive account and lists of, in fossil formations, 461 *et seq*.
Flints, formations in which found, chalk, ochre, trap, and conglomerates, 91, 93, 102, 110. Colour and other appearances of, 102, 111. Chemical condition of, in chalk; and analysis, 117. Description of varieties of, and localities where found, 208.
Fluor spar, how and where found, 214, 743.
Forster, Robert, Esq., deposit of shell marl near Dungannon; account communicated by, 740.
Fossils. Consideration of fossil remains, and the structure of the strata in which they are found, 7. Circumstances that influence the deposit of organic remains in different epochs and systems, 7, 8. Occurrence of organic remains in basaltic formations, adduced in support of theory of diluvial action, 37. Göppert's experiments on petrifactions, 18. Interesting fossil locality, Lynburn, Stradreagh, 48, 49. Fossilized woods, Lough Neagh, 75. Fossils connecting altered rocks at Portrush

with those of Ballintoy, 99. Account of those found, 100. Fossils found in formations of Benyevenagh, and similar fossils in distant formations, 107; at Tircorran, 108; at Tircreven Burn, 108. Descriptive enumeration of fossils found in lias formation, 118—140. Species of shells, &c., found in calcareous clays, &c., in Derry, 157, 159. Descriptive list of fossils in the silurian strata, 228, 252 *et seq.* Character of the fossils of the silurian strata, 233. Account of the class Crustacea, 234. Absence of fossiliferous transition strata of the Devonian system, 233. Views of various writers upon the crustaceous fossils, Trilobites, &c., 234—241. Peculiarities, classification, and affinities of Trilobites, &c., 241 *et seq.* Their descriptive nomenclature, 249—252. Detailed descriptive list of fossils in silurian, carboniferous, and cretaceous strata, 254, 304, 340, &c., 745. Value of, as a test of geological formation; general observations, 303. Descriptive account of those found in the shales, 313 *et seq.* Geological distribution of crustaceous fossils in the respective formations, 317. Fishes, formations in which found, and detailed descriptive account of, 460 *et seq.* List of fishes, from the mountain limestone of Armagh, 461. Summary of silurian fossils described, 476. Fossils found in carboniferous strata, 564, 568, 571, 573, 576. Fossil remains in the coal formations of Tyrone, 602, 627. General list of fossils, and synoptical table, showing their classification, localities, and formations in which found, &c., 749—769. See *Shells.*

Fox, Mr., on theories of igneous rocks, 18.

Foyle, Lough, geology of, 22—25. Extensive chalky limestone range, 33. Account of extensive shell banks in, 161—165. Enclosure of slob, 740. Foyle, valley of, 86.

Galena, where found, 226.

Garnet, description of, and localities where found, 209, 741.

Geology, considerations connected with the study of; colouring, divisions, signs, 1. Influence of physical features on intercourse and civilization, 2. Varieties of composition in the formation of the earth, 3. Systems that have been framed, and causes that led to them, 3, 4. Errors of older writers, 4, 25. Succession of strata. Wernerian nomenclature, 4. Means of identification, 5. Relation between the epochs of mineral and organic change, 6. Principles of comparison and deduction in geology. 7, 8. Fluidity and solution not necessary to chemical action and change, 16. Review of the works of preceding writers, 22—82. Indications of successive depositions or eruptions, in the relation of basaltic formations and ochre beds, &c., 45. Connection between geological features of Ireland and Scotland, 51. Physical features of the country and geological changes therein, 83, 86. Economic geology; statements on, 641 *et seq.* Mineral springs, 641: Climate and drainage, 649: Mineral statistics, 670: Soils, 688: Cultivation, 690: Agricultural schools, 710: Horticultural schools, 734.

Giant's Causeway, notices of, in Philosophical Transactions, 22: basalt and fragments of lava at, 28: Whitehurst's account of, 29: Rev. William Hamilton's account of, 30.

Giant's Grave (Magilligan parish, County Derry,) a detritic deposit, with shells; account of, 24, 27.

Giant's Sconce, basalt, 141.

Giesecke, Sir Charles, quoted, 113, 209, 218, 227.

Glenarm, beautiful limestone coast, 34: lias, 56.

Gneiss, account of formations of, 168—204.

Göppert. Experiments of, on petrifactions, 18.

Gorestown, Armagh, geology of; unsuccessful sinking for coal, 27, 28, 61.

Granite, speculations as to the origin of, 12, 18, 508, 521. Metamorphosis in, 516. Junction of granite formation with limestone, 15. Relations of granite and porphyry, &c., 16. Colour representing, red, 20. Letter representing deposit of, G. 21. Granitic formations and connections with greenstone, 60. Origin of granite, and contact with other strata, 507. Relation of, to trap dykes, 507. As to original condition of, and connection with other rocks, 508. Description of large mass of red granite, and metamorphic change in rocks connected with it, 515, 516. Extent and account of granite districts, 507, 515, 518, &c. Description of the granite of Slieve Gallion, 551. Epochs of formation of, 530. Table of quarries of, showing their localities, application, value, &c., 672.

Graptolites, in the silurian strata, 317 *et seq.*

Gravel. See *Detritus.* Chapter on detritic deposits; account and description therein, of gravel deposits, 630—640. Agencies by which deposited; localities, elevations, and other features of, 631, 632, 633, 636, 638, 640. Consolidation of beds of, by calcareous matter, and formation of conglomerates, 635. Descriptive table of quarries, showing localities, value, &c., 673—675. Tables of gravel, showing distribution, &c., 747, 748.

Gravity, specific, of indurated or altered schists; their great density, 172.

Green colours, representing basalt and metamorphic rocks, 20.

Greenough, observations of, as to construction of geological maps, 9. Mode of colouring adopted by, to represent geological features in maps, 9, 10.

Greensand. Account of strata of, 108, 109. Mixture of fossils of greensand and lias formations, 109, 132, 140.

Greenstone, connection of, with basalt, 57; with granite, 60; with schists, analysis of greenstone rocks, 178. Description of greenstone dykes, 495, 496, 510, 511, 741. Intersecting the sandstones, shown by Map, 506, 741. Descriptive tables of quarries, showing their localities, applications, value, &c., 673—675.

Griffith, Richard, Esq. Underlying and overlying rocks, coloured by, with same tint, 19. Remarks upon the Portrush Skerries rocks, 43, 44. Colouring of greenstone and basalt, 44. Geological and mining surveys of coal districts of Tyrone and Antrim, by, 59. Account of Annagher collieries furnished by, 599. On clay and coal tract, Tyrone, 167. Geological map by, 63. References to, *passim*.

Grits, appearances of, and connection with the red marl and other strata, 106, 107, 109. Relation of calcareous grits to limestone formations, 592. Carboniferous grits, their relation to limestone and shale formations, 596. Account of formations of carboniferous grits, 596, 597. Descriptive table of quarries, showing localities, applications, value, &c., 672.

Gypsum, account of and localities where found, 214.

Hæmatite, description of, and localities where found; red, 225; brown, 225.

Hall, Sir James, Bart., proofs of the Huttonian theory of the earth adduced by, 38. Opinion of, as to supposed aqueous formation of basaltic rocks, 39.

Hamilton, Mr., Secretary of the Geological Society, London,—on metamorphic formation of mica schist of Asia Minor, 19.

Hamilton, Rev. William, on the northern counties of Ireland; basalts and fossils; coast of Antrim, (1790,) 30.

Harringtonite, where found, 218.

Heulandite, description of, and localities where found, 222.

Hibbert, Dr., on carboniferous strata of Scotland, 564.

Hibernian Mining Company: collieries of, 607, 609, 613.

Higden, on Lough Neagh, 75.

Himalaya Mountains. Change of carbonaceous shales into mica schist, 18.

Hope, Dr. Observations of the basaltic rocks of Portrush, 39.

Hornblende. Letter designating deposit of, H. 21. Hornblendic schists, account of, 168—204. Description of hornblendic rocks associated with the schists, 170, 171. Succession of strata at Drumahoe described; woodcut, 171, 172. Character of, and localities where found, 210. Alternation of hornblendic rocks with schists; and connection with calcareous rocks, 553. Evidences of metamorphosis in hornblende rocks, 555.

Hyalite, description of, and localities where found, 207.

Hydrolite, description of, and localities where found, 221.

Hydrophane, description of, and localities where found, 208.

Hyndman, G. C., Esq., and James Bryce, Esq., on tertiary deposit of marine shells near Belfast, 737, 738.

Hypersthene, description of, and localities where found, 211.

Igneous rocks. See *Volcanic action*. Mr. Griffith's account of, 77. Chapter on igneous and metamorphic rocks, 507 *et seq.* Various results of igneous action extensively exemplified, 508. Detailed description of varieties of, 524.

Induration of beds from metamorphic action, 105.

Innes, Rev. Robert, rector of Magilligan, Derry: account (1732) of the natural history of the parish; its botanical richness, &c., zoological specimens, 23—27. Account of, with Bishop Nicholson, 82.

Iron, abundance of, in ochreous beds, 174. Oxydulated iron, octahedral iron ore, description of, and where found, 225. Micaceous iron ore, 225. Iron pyrites, 224. Phosphate of, where found, 226. Carbonate of, where found, 226. Silicate of, where found, 226.

Ironstone, account of beds of, 72.

Jasper, description of, and localities where found, 209.

Jenkinson, Rev. Mr. (Lowick) Berwick, fossils contributed by, 598.

Johnston, Professor: on agricultural chemistry and geology, 652, 688. On drainage, &c., 653.

Jones, Captain, M.P., list of fishes from mountain limestone of Armagh, and remarks by, 461, &c.

Kane, Professor, M.D. Report on mineral waters, 642. Analysis, 644. Table of constitution of mineral springs, 645. Table of temperature of mineral springs, 648. Analysis, &c., of bronzite, 742.

Keady, 35, 55, 56, 102. Geology of tract from, to Magilligan, 103, 105. Keady to Donald's Hill, 110.

Keilhau, Professor; on metamorphic formations, 13, 14: quoted, 99.

Kennedy, Dr., analysis of basalt, 117.

King, William, Archbishop of Dublin, (1702:) on geology of Derry and Donegal, 22.

Kirwan's instances in support of aqueous deposition, 37, 38.

Labradorite, where found, and appearance of, 212. Character and analysis of, 743.

Lady O'Cahan's Bridge; a dyke, 106, 155.

Lancy, Captain, observations at Lisnagrib, 49.

Landslips: undercliff of Benyevenagh, account of, 103, 104. Stratification of, 104; and at Craignashoke, 113. Causes of dislocation, 109. Aqueous action, and subsidence as shown by, 103, 104, 109.

Laumonite, locality where found, 218; and character and analysis of, 744, 745.

Legavannon, 84: pots of Legavannon and Leganannim, basalt; description and woodcut of, 148.

Lehuntite, account of, and localities where found, 221.

Lepidolite, how and where found, 212.

Levyne, varieties and description of, and localities where found, 219, 744.

Lhwyd, on fossil crustacea, 234.

Lias, account of formations of, 55. Tircreven, &c., 109. Position and phenomena of the metamorphosed lias, Portrush, 97. Identity of the Ballintoy beds and Portrush rocks, 97. Account of lias formation and descriptive list of fossils found therein, 118—140. Mixture of fossils of lias and greensand formations, 109, 132, 140. Comparison of mineral structure of altered lias and augite rock at Portrush, with the basalt, 150.

Lievrite, where found, 226.

Lignite, occurrence of at Lough Neagh, 74. Account of fossil woods, 75. Bed of, under basalt at Ballynascreen, 112: Slieve Gallion, 113. Localities where found, 227.

Lime, descriptive tables of kilns in Derry and Tyrone, their localities, produce, value, &c., 674, 675. Explanatory account of the lime kilns, 676, 677. Uses of lime, and its value in agricultural operations, &c., 677—679. Descriptions of land to which it is advantageously applied, and quantities used, 678.

Lime, carbonate of, prevalence and character of, in the various localities, 213. Nitrate of, its prevalence, and where found, 214.

Limestone. Metamorphosis and junction of limestone formation with granite, 15. Colour for representing, blue, 20; letter designating deposit of, L., 21. Account of strata of, in Derry and Antrim, 54. Limestone formations, and connection with other strata, 60. Divisions of, in Mr. Griffith's map and report, 66, 69. Mountain limestone, 62, 69. Upper or splintery limestone, 70. Millstone grit, 71. Limestone in connection with the schistose rocks, account of, 175. Localities of principal deposits of, 175. Wear and denudation of strata, 176. Detailed account and descriptive list of fossils in the mountain limestone, 254—313. List of fishes from mountain limestone of Armagh, 461. Limestone formation in connection with sandstones of Derry, 489. Contrast in aspect of eastern and western portions of limestone district, 562. Resemblance of, to strata in Scotland, 564. Succession of beds in deposit of, with sandstones, shale, &c., and description of, 579, 582, 583, 585. Description of limestone formations, course and connection with other strata, fossils therein, &c. 579 *et seq.* Relation of, to calcareous grits, 592. Descriptive tables of quarries, showing their localities, application, value, &c., 672—675.

Lisnagrib, geological features at, 48. Fossils, &c., 49. Lias, 56, 104, 107. Account of the lias formation, and detailed description of fossils in it, 118—140.

Lithomarge, description of, and localities where found, 210.

Londonderry, County of. Archbishop King's paper on the geology of Derry and Donegal (1708), 22. Extensive chalky limestone range, 33. Rev. Dr. Richardson, on geological alterations in, 34. Rev. George V. Sampson on chart and survey of, 46. Dr. Berger and Mr. Conybeare, on geology of, 50: description of mountain chain of, 50.

Loughs. Clays and sands of Lough Neagh and Lough Beg, of lacustrine origin, level of lakes formerly higher, 165. Changes of level, 165, 167. Lough Allen, 71. Belfast Lough, deposit of shells, 27. Lough Erne, 65, 67, 73, 85, 86. Lough Fea, 531. Lough Finea, 52. Lough Foyle, geology of, 22—25, 85: extensive chalky limestone range, 33: account of extensive shell banks in Lough Foyle; species found, 161, 162; their value for manure, and extent to which so used; amount of labour and cost of obtaining, 164, 165. Lough Melvin, 65. Lough Neagh, 36, 56, 62, 74, 75, 76, 85, 116. Lough Rey, 61. Lough Strangford, sandstone of, 53. Lough Swilly, 741.

Louth, County of, Dr. Berger and Mr. Conybeare, on geology of, 50.

Lusser, Dr., on quartz and serpentine rocks, 554.

Lyell. Hypogene theory of, in reference to metamorphic formations, 13. On the theory of eruptions, as regards igneous rocks, 18. Theory of metamorphosis, 508.

Lynn River coal, 47. Lyn fossil tract, 48.

MacLeay, on Crustacea, &c., 239, 240.

Madden, Dr., on drainage, 654.

Magilligan, parish of, County Derry; natural history of; its botanical richness, &c.; zoological specimens found there, 23—25, 55, 56. Mountains extending from Magilligan rock to Bienbraddock, 35. Overlying basalt at, 42. Coal, 47. Lias, 98. Chalkcaves, 102. Geology of tract from Magilligan to the Keady, 103, 108.

Magnesite, account of, and localities where found, 214.

Magnetic pyrites, where found, 225.

Malm Rock, (White's Selborne,) 111.

Manure. Manner of manuring lands by sea shells in Derry and Donegal, 22. Tertiary fossiliferous clays, useful for, 49, 50. Extent to which shells are used for manure, and amount of labour and expenditure in obtaining them at Lough Foyle, 164. Submarine peats used as; account of, in Carnarvonshire, and use of, 166.

Maps. Methods of representing geological features by colours and other signs, 8. Modes which have been adopted by various geologists, 9, 10. System of colouring adopted by Ordnance geologists, 10. Colours and signs explained, and principles upon which they have been adopted, 8—21. Griffith's Map, account of, 63: notices of, 478, 481, 483, 490, 499, 504, *et passim*. Sampson's map of Derry, 50.

Marl, beds of, Benyevenagh, and formations with which they are connected, 105. Induration of, from metamorphic action, 105. Deposit of shell marl near Dungannon, 740.

Merog, or Finger-stone, (Lough Foyle) description and view of the rock, 25.

Mesole, description of, and localities where found, 224.

Metamorphosis in geology. Epochs of change and means of judging of them, 5, 6. Opinions and difficulties as to metamorphic productions, 13, 18, 519. Fluidity and solution not necessary to chemical action and change, 16. Action of change in various formations, 17, 18. Changes of siliceous schists into mica schist and gneiss, and the latter into granite, 19. Changes into mica and hornblendic schists, 19. Colours by which metamorphic crystalline schists, and metamorphic rocks, &c. are represented, 20. Griffith's account of metamorphic rocks, 77. Changes in the physical features of the country, 83, 86: in secondary strata and overlying trap rocks, 91, 92. Metamorphic origin of certain rocks, and their relation to igneous rocks, 97. Phenomena of metamorphic rocks of Portrush, 98, 140. Evidence of metamorphic change, 99, 102: in hornblendic schists, 170. Induration of beds from metamorphic action, 105: detritic deposits, 635. Metamorphic action and changes in reference to basaltic formations, 146, 155: elevations of various basaltic mountains, 156. Evidence of metamorphic peculiarities, 175. Examples of metamorphic action amongst the sandstone formations, 487, 492. Chapter on metamorphic and igneous rocks, 507 *et seq.* Views on the theory of metamorphosis, 508. Interesting district, showing various results of, 509: description of, 510 *et seq.* Changes of rocks from sandstones into crystalline rocks, 513, 529. Sandstones replaced by porphyries, 529. Probable epochs of phenomena described in regard to igneous and metamorphic rocks, and modes of judging, 557.

Mica schist: varieties of, in district of Derry, &c., 14. Account of groups of, 53, 168, 204. Map of formations, 64. Detached tract of, in Donegal, a portion of an extensive whole, Antrim and Scotland, 169. Mica, of general occurrence, 212.

Micaceous iron ore, account of, and localities where found, 225.

Mills, Mr. Abraham, on the strata and volcanic appearances in the north of Ireland and western islands of Scotland, 45.

Millstone grit, formations of, 71.

Minerals, detailed examination of structure of the basalt, as compared with the augite rock and altered lias of Portrush, 150. Chapter on the simple minerals, 205: addendum, 741. Inquiry into minerals, and detailed account and classification of the several species found, their localities, &c., 206—227, 741—745. Mineral springs, account of, and report by Professor Kane on, 641—648. Tables, showing constitution of springs, 645: temperature of, 648. Mineral statistics, 670–687. Connection of mineral products with geological science, 670. Their use, and purposes to which applied, 670, 671: exhibited by tables, 672, 673, 675, 683, 684.

Mollusca, account of, found in the silurian strata, &c., 364 *et seq.*

Molyneux, Dr., on Lough Neagh, 75.

Moore, Dr. (Dungiven,) on minerals, 222.

Mountains, characteristics of, and influence on climate, inhabitants, communication, &c., 2. Differences between mountain range of Down or Mourne mountains and that of Derry, 50: compared with Scotch mountains, 51. Description of mountain features of the country, 84. Elevations of basaltic mountains, 156.

Mourne Mountains, account of, 50.

Murchison. Mode of colouring adopted by, to represent geological features in maps, 9, 19. References to, 228, 230, &c.

Natrolite, description and varieties of, and localities where found, 216.

Naumann's account of junction of limestone and granite formations, 15.

Ness waterfalls; woodcut, 176.
Neuwid, basin of (Rhine), 76.
Nicolson, Dr., Bishop of Derry, inquiries into the natural history of that diocese, (1725), 23. Extract from journal of, (1718,) 81.
Nitrate of lime, prevalence of, 214.

Obsidian, description of, and localities where found, 212.
Ochre, account of beds of, amongst basaltic formations, 31, 32, 35; at Benyevenagh, 103. Relation of, to basaltic formations, 31, 32, 35, 44. Results of their connection, 116. Ochreous paste formations near Ballycastle, 91. Imbedded in chalk at Ballintoy, 92. Amongst the schists, 173. Localities where met with, and character of, 173. Analysis of ochres of the schists and the basalt respectively, 173, 174. Utility of, and purposes, 174, 203; prices and modes of preparation, 203.
Oldham, Mr. Thomas, detailed examination and description of the mineral structure of the basalt, in comparison with augite rock and lias, 150. Arrangement of minerals by, 205, 206.
Olivine, account of, and localities where found, 211.
Onyx, account of, and localities where found, 209.
Oolitic formations at Benyevenagh, 107. Descriptive exemplification of oolitic system, 108, 109.
Opal, description of, and localities where found, 208.
Organic remains, as elements of geological reasoning, 6. Circumstances that influence the deposit of, and the strata in which they are found, 7. Occurrence of in supposed basaltic formations, adduced in support of theory of diluvial action, 37. See *Fossils*.

Pander, on Trilobites, 243 *et seq*.
Pearlstone, where found, 212.
Peat. See *Bog*.
Petrifaction. Göppert's experiments upon, 18. Petrifaction of wood, Lough Neagh, 75. Petrifactions in silurian strata, 235. See *Fossils*.
Phillips, Professor: index geological map, 63, 64. Transition member of, or alternating sandstones and limestones, 572, 578, 593, 596.
Phillipsite, description of, and localities where found, 222.
Philosophical Transactions; notices on Giant's Causeway, 22.
Phosphate of iron, where found, 226.
Pitchstone, where found, 212.
Playfair, on the supposed aqueous formation of basaltic rocks, 39.
Pleaskin, Cape; description and successive formations of, 31.
Plinthite, localities where found, 217.
Pliocene, newer; deposits of, and basaltic pebbles, &c., therein, (Derry), 165. Notice of an elevated deposit of marine shells, of newer pliocene epoch, at Belfast, 738.
Poikilitic formations, descriptive account of fossils in, 468 *et seq*.
Porphyry, in connection with the sandstone formations, 493, 495, &c. Account of porphyritic rocks, 523. Descriptive detail of, 526, 528. Views as to origin of, in Antrim and Tyrone, 529, 530. Epochs of formation of, 530.
Porter, H., Esq., Secretary of Hibernian Mining Company. Account of strata bored through in Drumglass coal field, 614.
Portrush, 91, 92, 96. Remarks on the geology of, 97 *et seq*. Difference of opinions as to the basaltic formations at, 38—44. Formations of, 56, 58, 73, 77, 81. Shelly deposits at, 23—38: basalt and fragments of lava, 28, 29. Chalk cliffs, 33: destruction resisted by induration, 34. Account of the augite rock and altered lias of, as compared with the mineral structure of the basalt, 150. References to, *passim*.
Pots of Legavannon and Leganannim, basalt; description and woodcut, 148.
Potteries, descriptive account of, their use and working, &c., 680, 682. Table of their localities, produce, cost, &c., 684.
Prehnite, not found in Ireland, 209, *note*.
Pyrites, Iron, account of, and localities where found, 224, 685; magnetic pyrites, 225. Favorable localities for working in the north, where, however, it is not turned to account, 685. Mode of manufacturing sulphur, and advantageous opening for the trade, 686. Copper pyrites, where found, 226.

Quarries. Descriptive tables of quarries of various kinds of rock, in Derry, Tyrone, Fermanagh, and Armagh, showing the products, purposes to which they are applied, value, &c., 672—675.
Quartz, abundance of, in schistose district, 175. Analysis of quartz rock, variety of schist, 178. Quartz slate, character of, in schistose formations, and analysis, 178, 179, 183. Quartzose rocks described, 183. Character of, and localities where found, 206.

Rain. See *Climate*.
Red colours, representing granite, and metamorphic crystalline schists, &c., 20.
Rhodalite, description of, and localities where found, 223.
Richardson, Rev. Dr., (Clonfecle), on geological alterations in Derry and Antrim, (1808), 34, 38—44. References to, 149.
Roads, effect of geological configuration on

road-making and means of communication, 86.
Rocks, relations and phenomena of the various kinds of rock formations, igneous, metamorphic, intermediate, &c., at Portrush, &c., 97, 99. Combinations of these kinds, in Glenrandal River, 173. Effect of the action of the sea on form of rocks, 95, 102. Igneous and metamorphic rocks; their classification, origin, &c., 507.
Rock crystal, description of, and localities where found, 207.
Roe River, Derry, 85: account of the Giant's Grave at various parts of, 24. Demarcation between primary and secondary formations, 53.
Russia. Prevalence of white colour and flint, in the mountain limestone of, 10.

Salisbury Crag, whinstone and jasper, 39.
Sampson, Rev. George V., chart and survey of Londonderry, 46—50.
Sand. (See *Detritus.*) Descriptions of, and shells therein, in Derry, 159: connected with bog, 161. Remarkable accumulation of shells and sand, near Portrush, 161; list of shells therein, 162. Sand and clay beds of Lough Neagh and Lough Beg, 161; origin and character of, 165. Chapter on detritic deposits; account therein of sand deposits, 630—640. Agencies by which deposited, localities, elevations, and other particulars, 631, 632, 633, 636, 638, 640.
Sandstone, colour for representing, yellow, 29. Letter designating deposits of sand and sandstone, A., 21. Difficulties connected with formations of, 53, 58, 61. Ages of, 54; variations of, 55, 59, 61. Description of sandstone formations, 6, 19, 62, 71, 73, 78, 79. Divisions of, 62, 66. Description of map of, 65. Account of strata underlying the basalt, from chalk to new red sandstone, 90—118. Enumeration of fossils found in lias formation, 118—140. Character of new red sandstone, of Benyevenagh, and beds connected therewith, 104, 105, 110. Chapter on the old red sandstone and new red sandstone, 477. Difficulties of forming distinctive lines of separation of sandstones, and confusion of formations in maps, &c. 477.—Nature of obscurities explained, 480, 501, &c. Objections to the designation of geological formations by colours, 478. Division denominated yellow sandstone, by Griffith, 478. Inaptness of that designation, and character of the formation, 479. Marks of division in the sandstones of Derry, Tyrone, and Fermanagh, 480, &c. Course, and descriptions, and extent of strata, 481, 483, &c. Fossils in, and in formations connected with, 480 *et seq.* Formations in conjunction with, 481, &c. Variations in character of, 481. Composition of old red, in Derry, 488. Resemblance to poikilitic formations, 482. Indications of carboniferous strata connected with, 482, 498. Basalt in connection with, 483. Beds of, alternating with shales, conglomerates, &c. described, 575, 576; with limestone, &c., 579, 582, 584. Descriptive tables of quarries, showing localities, application, value, &c., 672—675.
Sarcolite, at the Causeway, 220.
Sawel, height, &c. of, 51, 83, 84.
Schists, various characters of, and opposing opinions as to their origin, 12. Colours for representing, 19, 20. Character of hardened schist formations, Portrush, 99. Account of the crystalline schists, gneiss, mica schist, hornblendic schist, 168—204: ochre amongst the schists, 173. Anterior to the secondary strata, 168. Course and dip of the strata, 169, 171. Irregularities and alternations of, 171. Succession of, and of other strata, 172, 173. Great density of indurated or altered schists; specific gravity, 172. Detailed account of varieties and mutual relations of schistose rocks; illustrations by sheets and Nos., 177, 178–204. Cleavages in, their direction and irregularity, 179. Account of, in silurian district, and fossils found in connection with, 229, 230. Enumeration of fossils in, 231 *et seq.* Description of district of altered schists, 530. (See *Metamorphosis*, &c.) Origin of, 531. Micaceous and metamorphic schists, 531. Descriptive tables of quarries, showing their localities, application, value, &c. 762–675.
Scolezite, description of, and localities where found, 217.
Scotland. Comparison between geology of parts of, with north-eastern counties of Ireland, 45, 50, 51, 57, 83, 169. Carboniferous strata, 564, 565.
Scouler, Dr., on Lough Neagh, 75.
Secondary rocks, changes in; contact with overlying trap rocks, 91. Relative position and formation of, as regards the crystalline schists, &c., 169.
Selenite, where found, 214.
Serpentine, localities where found, and in what form, 211.
Shales, descriptive account of fossils in, 313 *et seq.* Account of formations of, and of fossils therein, 569, *et seq.* Beds of, alternating with calcareous bands, described, 574: with sandstone, conglomerates, &c., 575, 576:—with limestone, &c., 579, 582, 585. Account of shales, connected with limestone formations, 593—596. Shales and clay, colour for representing, brown, 20; letter designating deposit of, C., 21. Strata of, in connection with sandstone and oolitic systems, 107.

Shane's Castle, columnar basalt at, 36, 76.

Shells. Manner of manuring lands with sea shells in Derry and Donegal, 22. Deposits of, Lough Foyle, Newtown Limavady, 22; Portrush, 23. Shellbank at Ballycastle Orchard, the Giant's Grave, 24: at Skrieve, account of, 26: at Belfast Lough, 27. Presence of, in supposed basalt erroneously adduced as evidence of aqueous origin of basaltic formations, 37—39, 40, 41. Shells found in diluvial beds in Derry, 157. Localities and elevations where found, 158. In sand-drifts, &c., in Derry, 161. Remarkable accumulation of shells and sands near Portrush, 151; list of shells therein, 162. Extensive shell-banks of Lough Foyle, 163: Account of, and mode of formation, 163: Extent and value of, for manure, 164; Amount of labour and cost of obtaining shells for manure, 164. Shells preferred to lime for manure, 165. Shell beds of flats of Myroe, &c.; continuance of formative and elevating processes, 165; and features of other shell formations, 166. Notice of an elevated deposit of marine shells, of the newer pleiocene epoch, lately discovered near Belfast, 738. Deposit of shell marl, near Dungannon, 740.

Signs for representing geological features in maps, &c., 8. Colours adopted, explained, 20. Geological epochs distinguished by signs and numbers, explained, 21. Forms of mineral deposits represented by letters, explained, 21: order of deposit, by figures, 21. Difficulty of designating formations by colours alone, 478.

Silicate of iron, where found, 226.

Silurian strata, account of map of, 64. Chapter on the silurian strata, and descriptive list of fossils, 228, 252 *et seq.* Great variety of species found therein, 228. Position of, 229. Character of, and features of rocks connected with them, 229, 232. Extent and direction of, 229. General features of silurian district, 231. Ages of deposits, 232. Fossils of, their character, 233. Account of crustaceous and other fossils, 234, 254. Detailed descriptive list of silurian fossils, 254 *et seq.* Summary of silurian fossils described, 476.

Sinclair, Mr. Edward, account of Bartley coal pits by, 609: of Drumglass collieries, 613.

Skerries, or Skerry Islands. Formation of these rocks, 5. Characteristics of, 5, 40—43. Referred to, 98, 99, &c.

Skrieve, shell bank at; part of the Giant's Grave, 24, 26.

Slates. Colour for representing, 20; letter designating deposits of, S., 21. Clay slates and quartz slates in Donegal, 170. Character and analysis of, in schistose formations, 178, 179, 183.

Slieve Beagh Mountains, 68.

Slieve Buck, 84.

Slieve Gallion, formations of, 51, 52, 55, 59, 60, 62, 70, 77, 80, 85, 97, 113, 114, 487, 508, 550, &c. Porphyry and granite, 46.

Slieve Gallion Carn, 85, 113.

Slieve Girkin, 53.

Slieve Kirk, 84.

Slieve Kurkagh, 72.

Slieve Mish, 58.

Slob, of Lough Foyle, 740. Lough Swilly, 741.

Smith, Mr. on Lough Neagh, 75.

Smith, Mr. (of Deanston), on drainage for agricultural purposes, &c., 655 *et seq.*

Smith, Mr. (of Jordan Hill), on shelly deposits at Portrush, 23. List of shells collected by, 162.

Soils. Variety and richness of, in Magilligan parish, County Derry, 23. Good quality of soil connected with sandstone formations, but subject to modifications, 505. Mode of ascertaining quality of, and their comparative fertility, 688. Composition of; analysis and table of, 689.

Spa. See *Springs.*

Spars, account of, and localities where found; bitter or brown spar, 214; fluor spar, 214, 743.

Sphærosiderite, how and where found, 226.

Springs. Account of mineral springs, and report by Professor Kane thereon, 641—648. Localities and formations in which mineral springs occur, 641. Specimens of mineral waters examined, and analyses thereof, 642, 643. Report on analysis of water from Toel's well, Ballycallaghan, 644. Tables of the constitution of various mineral springs, 645; of their temperature, 648.

Stalactites. Caves containing stalactite matter, 103.

Staurolite, form of, and where found, 211.

Stellite, specimen of, found at Portrush, 215.

Stewartstown, (County Tyrone); extensive chalky limestone range, 33. References to, 62, 70, 116.

Stilbite, description of, and localities where found, 221.

Stratification. Varieties and successive formation of strata; Wernerian nomenclature, 4, 5, 52. Principles of comparison and deduction as regards stratified deposits, 7. Structure of strata in which fossils are found, 7, 8. Mode of representing, in maps, by colours or other signs, 8, 9. Mode of designating deposits, and their order explained, 21. Connection of formations in Scotland and Ireland, 51. Position of basalts in regard to secondary strata, that of overlying rocks, 42: succession of strata, at Cape Pleaskin, 31. Contact of overlying trap rocks with secondary strata, 91. Grits,

&c., 48. Limestone, &c., 54, 60. Dip of chalk strata, &c., 95, 98, 102. Chapter on the strata underlying the basalt, from the chalk to the new red sandstone, 90—118: enumeration of fossils found in lias formation, 118—140. Succession of strata described, at Benyevenagh, 107: stratification of undercliff, Benyevenagh, 104: Tircorran, 108: Tircreven Burn, 108. Dip and disturbance of strata, 108: greensand strata, 108, 109. Striking appearances at Tamlaght quarry, 114. Sections of basaltic masses at various localities, 142—145, 152—154. Clays with sandstone and oolitic systems, 107: calcareous clay formations, 157; alternations of clays, 160. Course and dip of schistose strata, 168, 169, 171: irregularities and alternations of, 171: schists and other alternating strata, Drumahoe, &c., described; and woodcut, 171—173. Alterations and dislocations of schists and limestones, 176, 177. Chapter on the silurian strata, and detailed descriptive list of fossils, 228—476: and carboniferous strata, 303 *et seq.*: and cretaceous, 340 *et seq*: triasic, 460: poikilitic, 468. Chapter on old and new red sandstones, 477—506. Chapter on igneous and metamorphic rocks, 507—559. Chapter describing the carboniferous strata, 560—629: succession of beds described, 566, 583, 585; with calcareous beds, 574, 575, 576, 579, 582. Succession of strata bored through, in coal formations, 28, 167, 600, 601, 610—612, 614—619, 629. See *Conglomerates*, *Dykes*, &c.

Streeve, shell bank at, 24, 26.

Strontianite, not found in Ireland, but strontian in arragonite, 215.

Studer. Opinions of, as to the origin of schists, granite rocks, &c., and metamorphic productions, 13.

Sulphate of barytes, account of, and localities where found, 215.

Sulphur. See *Pyrites*.

Syenite. Account of formations of, at Newry, in Down, and Derry, 52. Griffith's account of syenitic rocks, 77. Syenites and granites of Slieve Gallion, interesting evidences of metamorphosis, 508, 509. Modifications produced by protrusion of igneous rocks, 512.

Templemoyle Agricultural Seminary, account of, 710.

Templereagh Coal Pits, account of, 629.

Tertiary deposits, early notice of some of them in Derry, 22. Mr. Griffith's description of tertiary formations, 74. Description of tertiary formations in Derry, 157. Shells and fossils in, 158. Course and manner thereof, 159. Further description of tertiary deposits and shells therein, in appendix, 737. Notice of an elevated deposit of marine shells lately discovered, 738.

Thompson, Dr. quoted, 115: account of minerals, 214, 215, 218 *et seq.* Analyses of minerals, 742—745.

Thomsonite, varieties of, and localities where found, 215.

Tircrevin Burn, 108, 109: coal at, 47.

Tourmaline, account of, and localities where found, 212.

Trap, description of, and of formations comprised in, 57, 523. Contact of overlying trap rocks with secondary strata, and changes therein, 91. Account of trap dykes, 523.

Triasic strata. Descriptive account of fossils in, &c., 460 *et seq.*

Trilobites. Views of various writers upon, 234, 241. Peculiarities, classification, and affinities of, 241 *et seq.* Descriptive nomenclature, 249, 252. Detailed descriptive list of, 254 *et seq.* Value of, as a test of geological formation; general observations, 303. Further list of, 304 *et seq.*

Tyrone, County of. Extensive chalky limestone range, 33. Dr. Berger and Mr. Conybeare, on geology of, 50. Mr. Griffith's survey of coal districts of, 59. See *Coal*.

Ulster flœtz trap, 57.

Undercliff. Landslips and undercliff of Benyevenagh, 103, 104. Stratification of, 104.

Verner's Bridge, 76.

Vincent, Rev. J. V., on value of submarine peat as manure (Carnarvonshire), 166.

Volcanic action. Formation of slate districts militate against the theory of eruptions, 15. Opinions thereon, 18, 29. Illustrations of, Coleraine, Causeway, &c., 28, 29. Origin of basaltic mountains, attributed to eruption, 29, 30. Controversial views as to volcanic or aqueous origin of basaltic formations, 29, 37, 40. Speculations as to the rocks of Portrush, 41. Appearance of the features of the country, 86. Relations between classes of erupted rocks, 97. Illustrations of volcanic action and effects in the basalt, 146, 148. See *Igneous Rocks*.

Wahlenberg, on petrifactions, silurian fossils, 235 *et seq.*

Washing Bay, 74.

Weather. See *Climate*.

Wells. See *Springs*.

Werner, nomenclature of, from succession of strata, 4. Newer granite of, 52.

Whitehead, The, Carrickfergus bay, 33.

Whitehurst, John, (1786,) account of geology of the north of Ireland by, 27—30.

White Park Bay, limestone at, 33. White Park cliffs, 40, 41.

White Rocks, (Dunluce), 92, 93, 98, 116.
White's Selborne, 111.
Wicklow Mountains, 52.
Wiggins, Henry, Esq. Jun., statement of particulars, showing extent and value of shell deposits at Lough Foyle, 164. On improvements in drainage and management of Grocers' Company's estates, 657.
Wilkinson, George, Esq., architect of Poor Law Commission. Observations of the weather, made under direction of; and returns contributed by, 89, 649. Abstract of weather returns, 650. Tables furnished by, referring to different parts of Ireland, showing popular impressions of the weather, 662.
Woollastonite, where found, 214.

Yellow colour, representing sandstone, 20.

Zenker on Trilobites, 247 *et seq.*
Zoisite, kinds of, and localities where found, 209.
Zoology. Zoological evidences as elements of geological reasonings, 6.
Zoophytes, account of, in the silurian and carboniferous strata of Fermanagh and Tyrone, 317 *et seq.*

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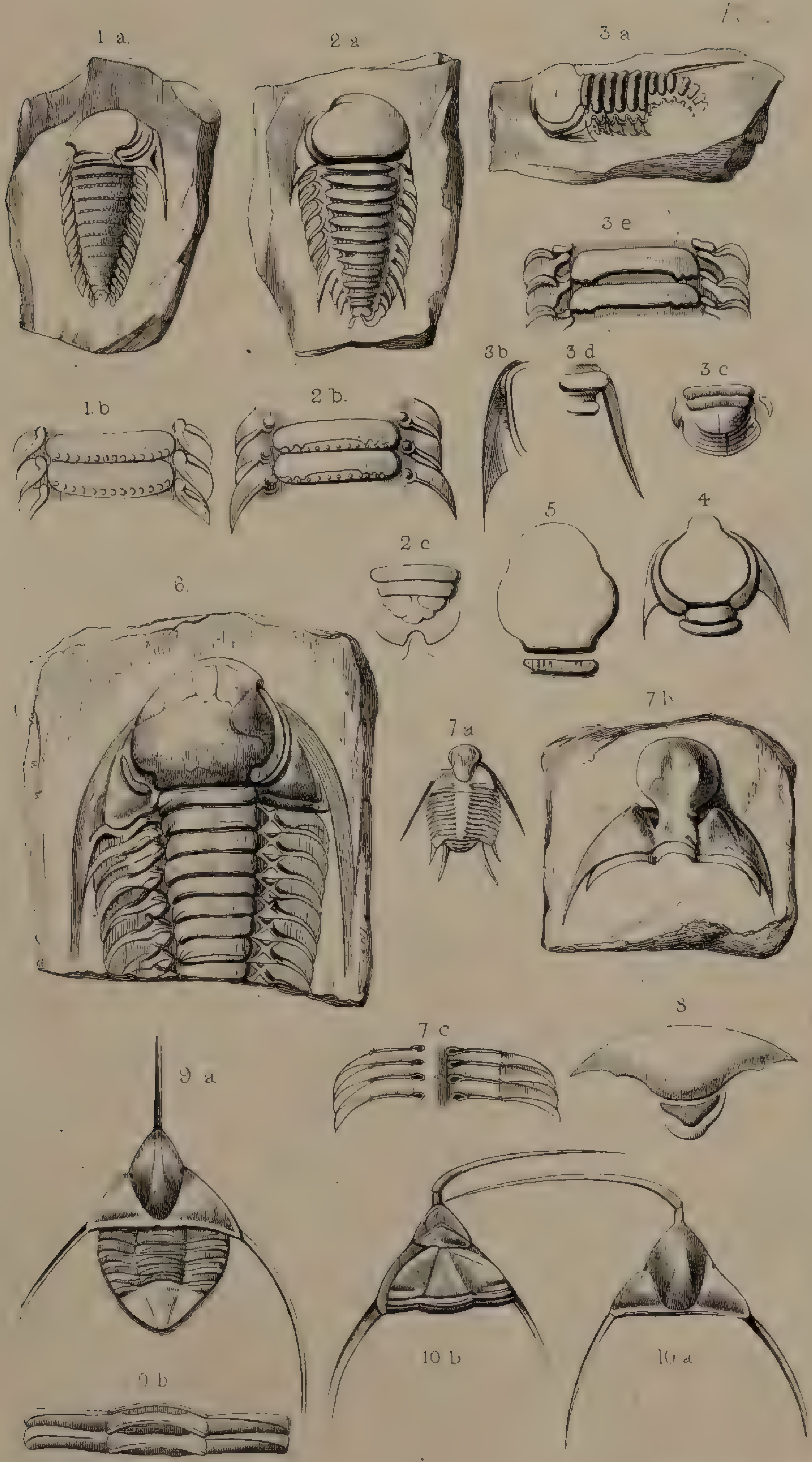

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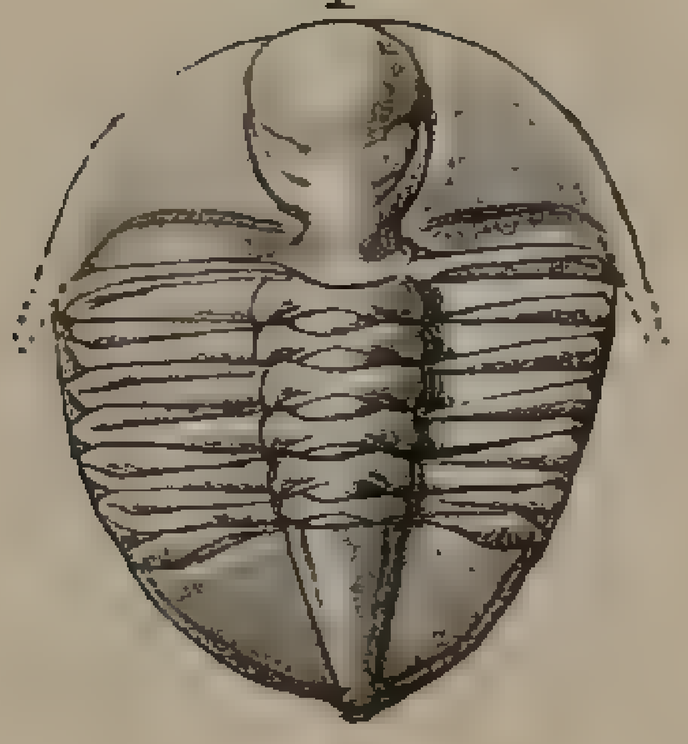

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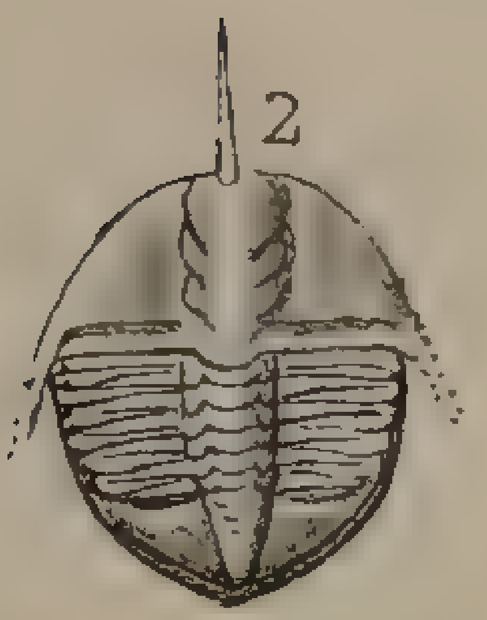

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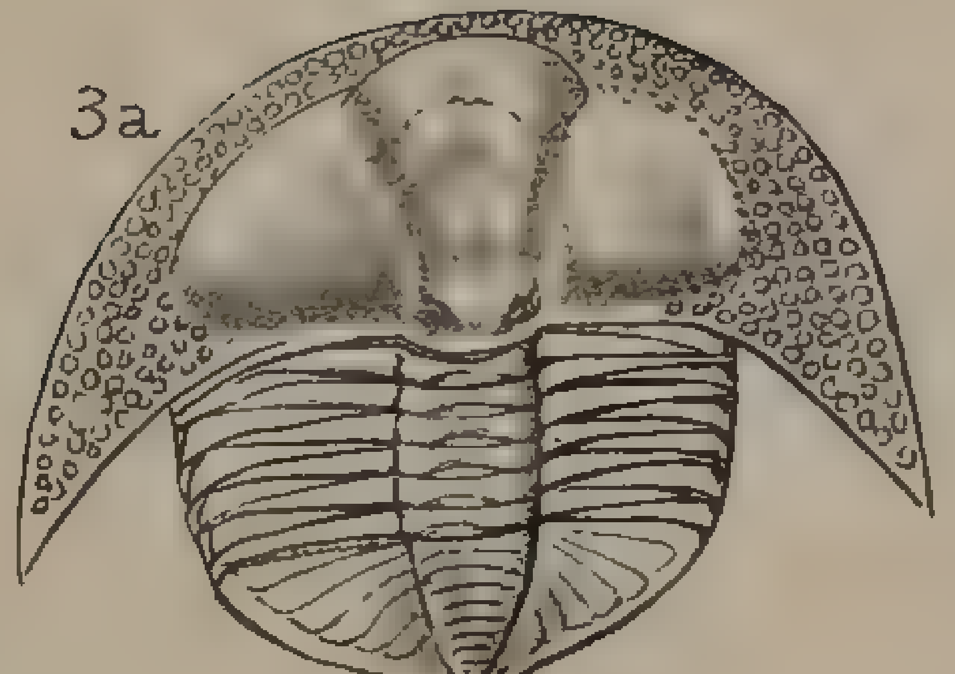

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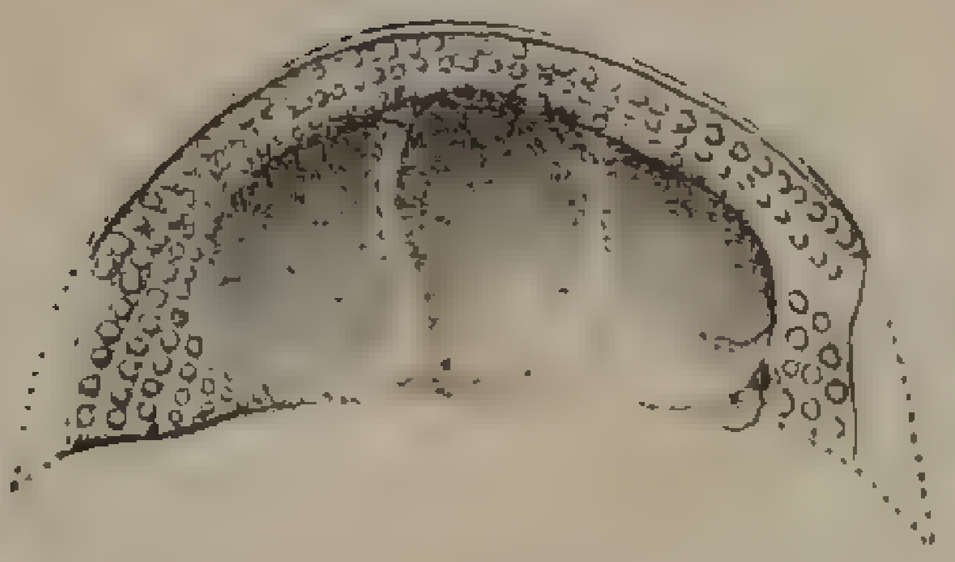

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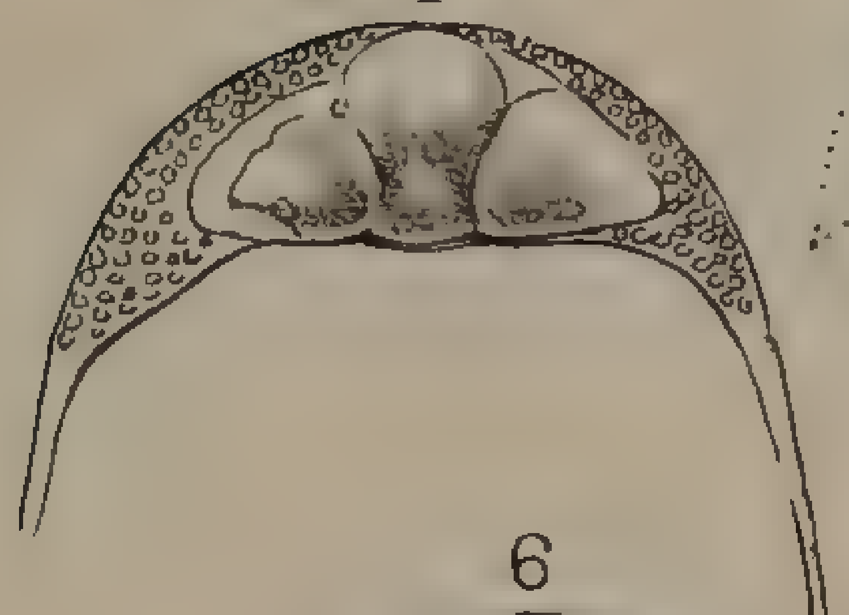

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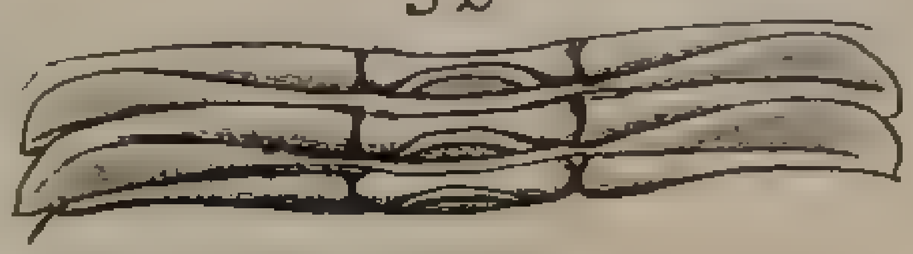

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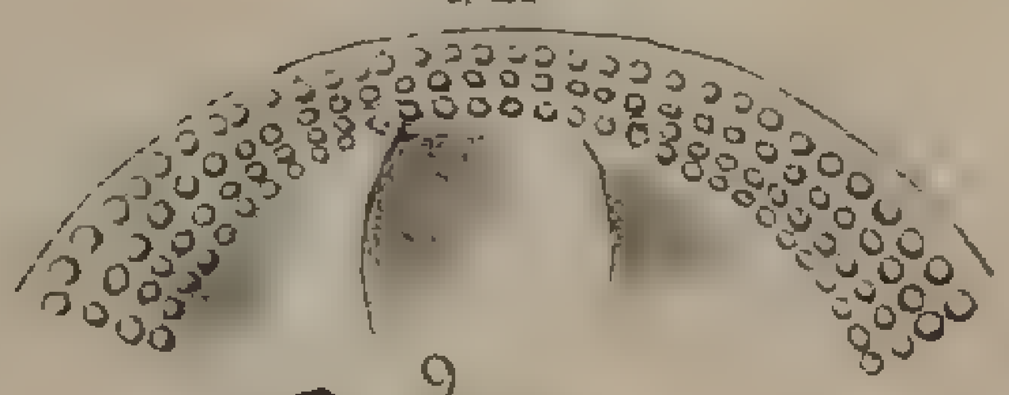

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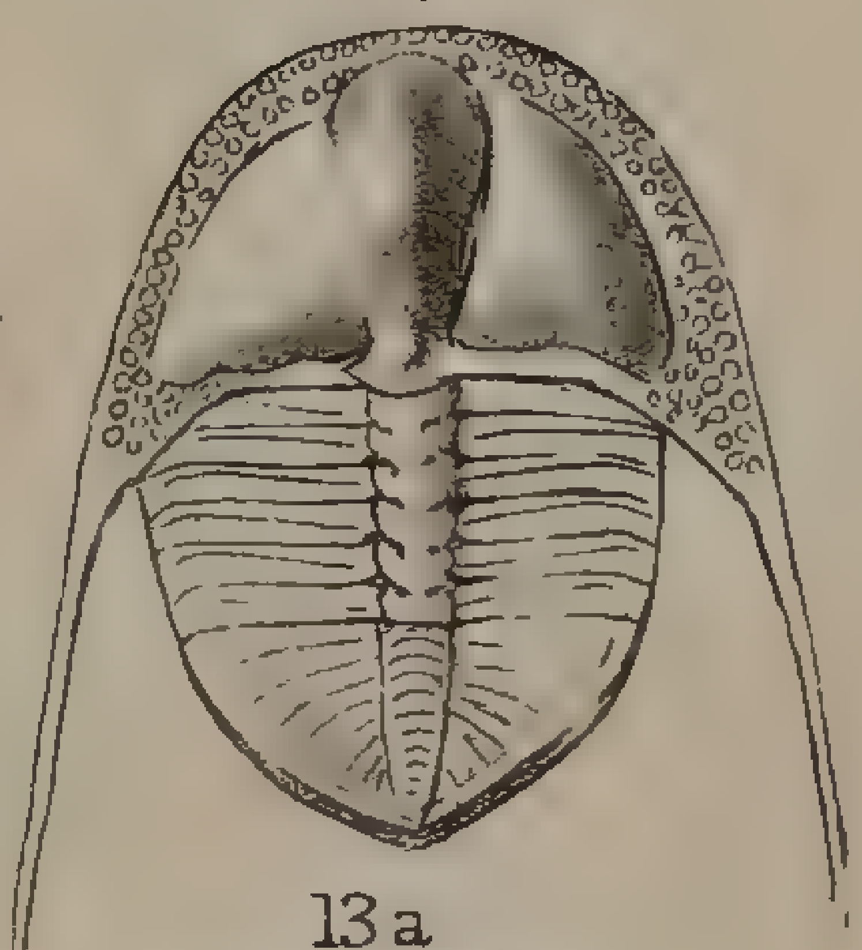

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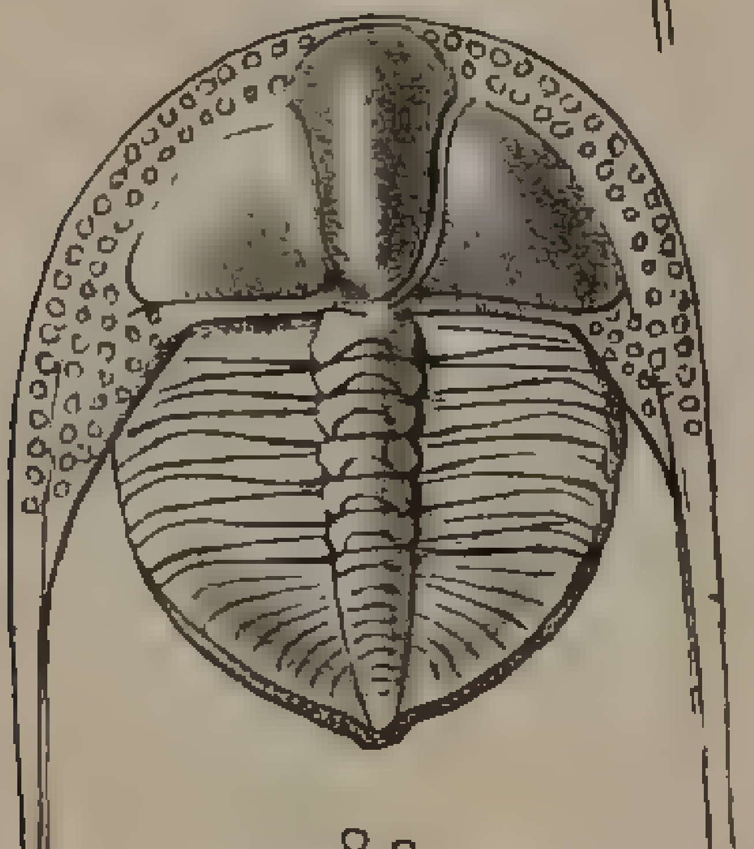

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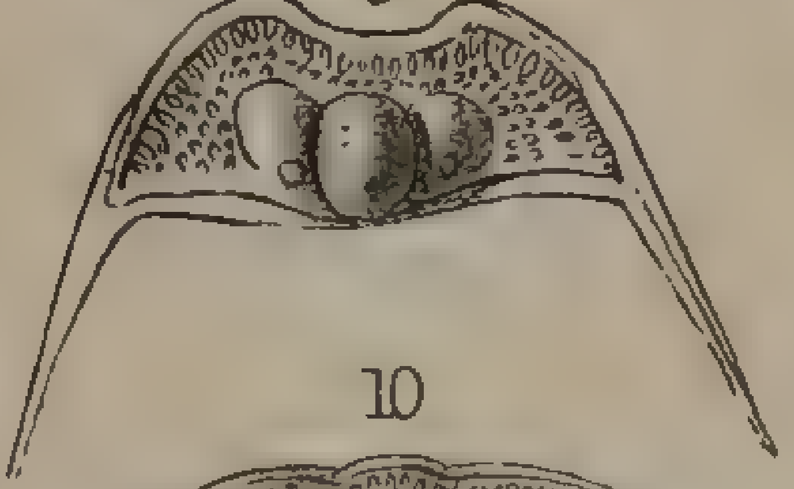

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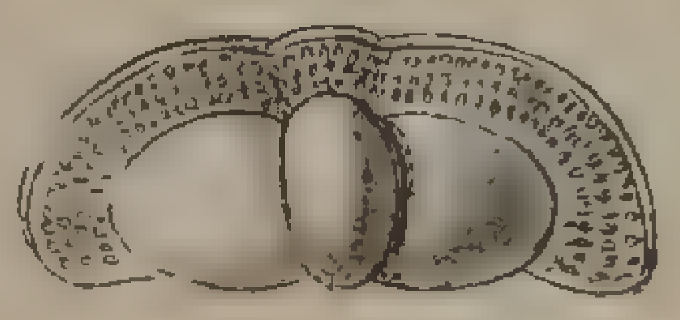

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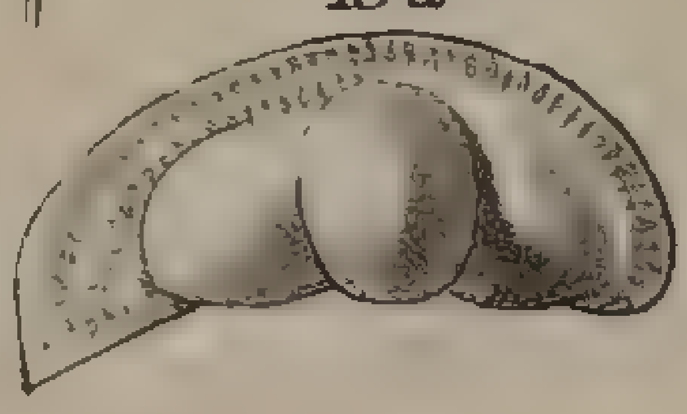

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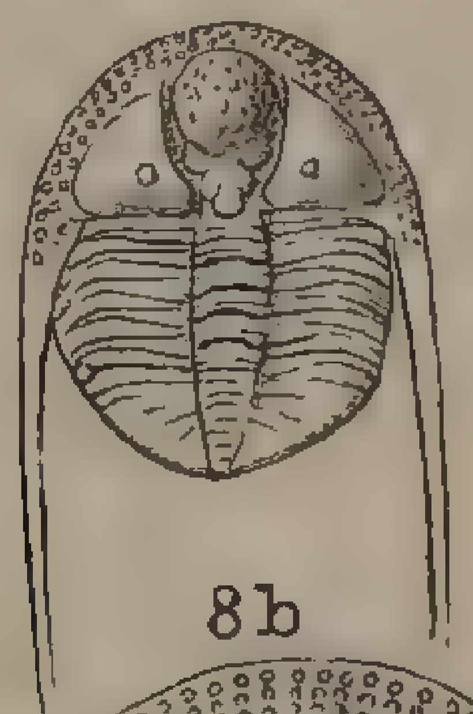

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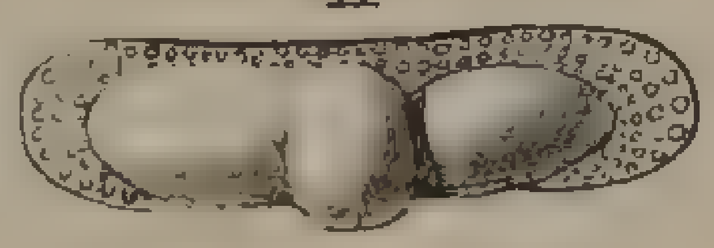

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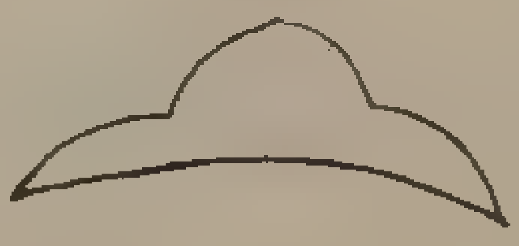

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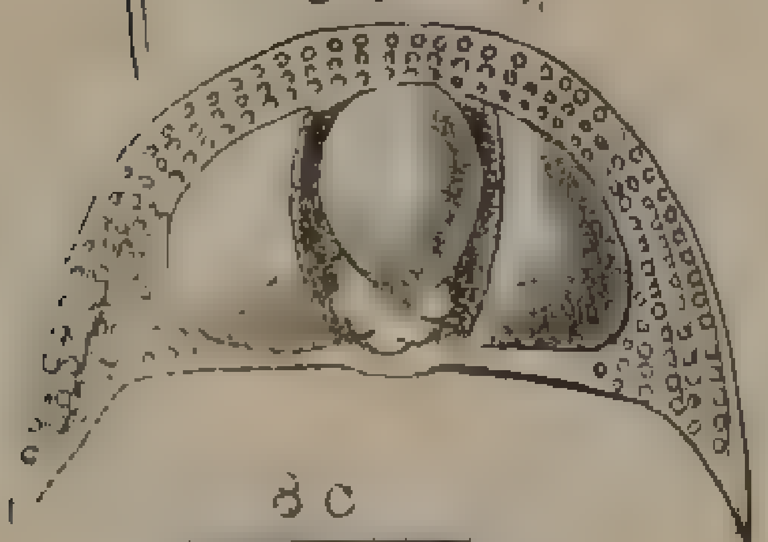

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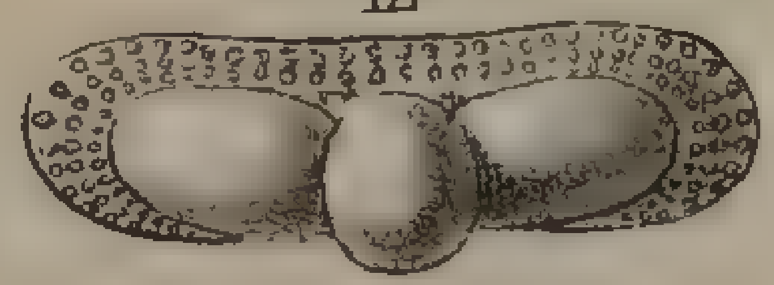

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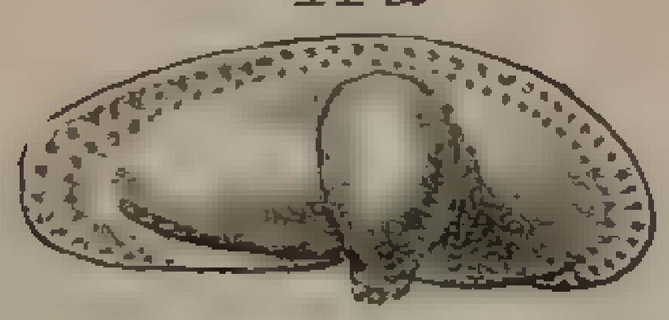

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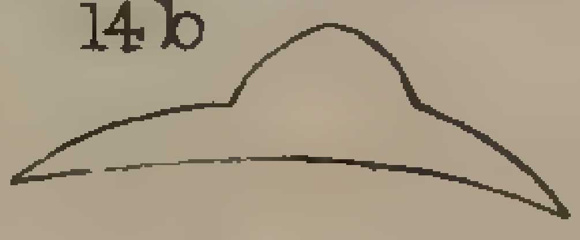

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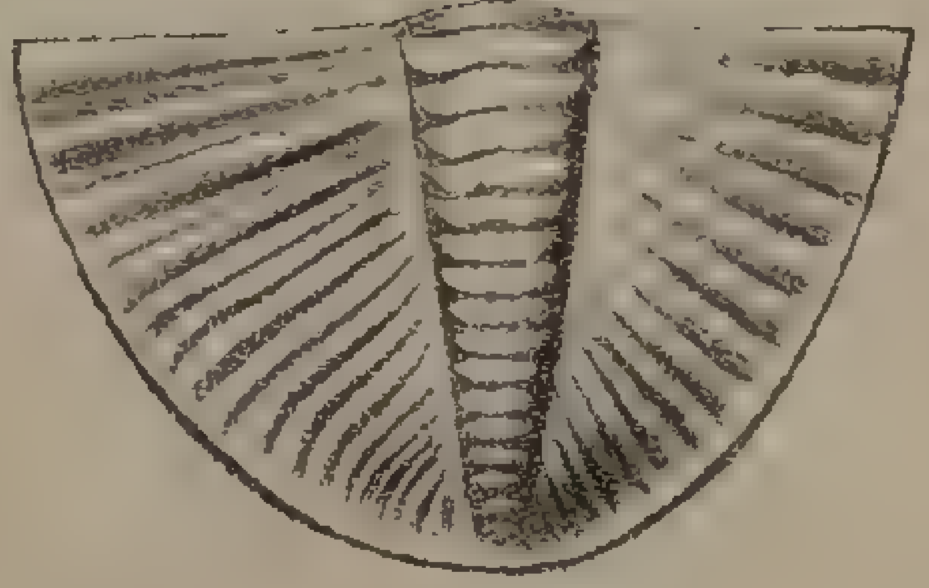

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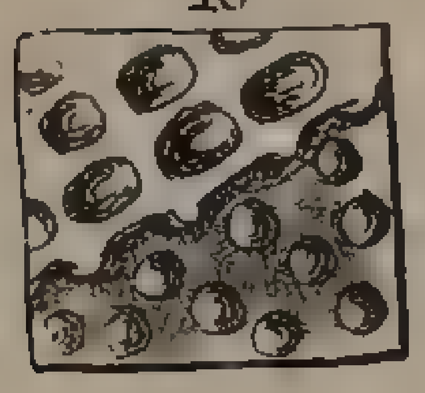

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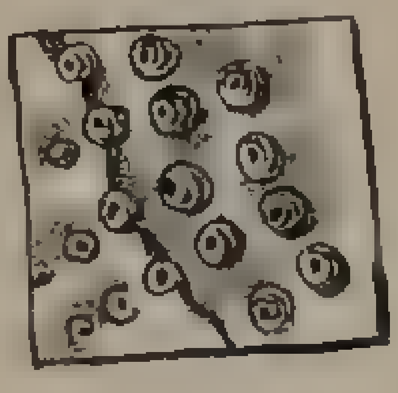

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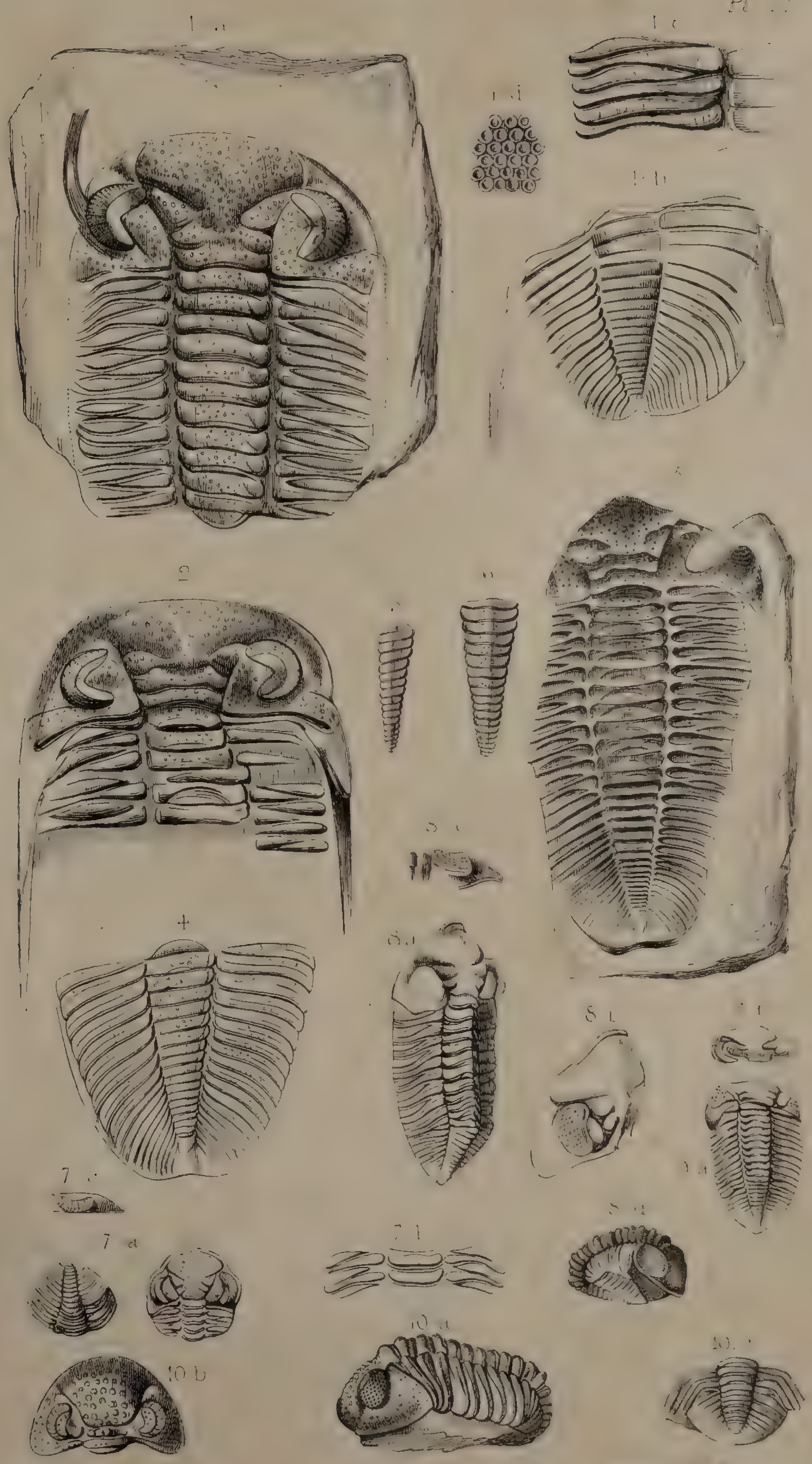
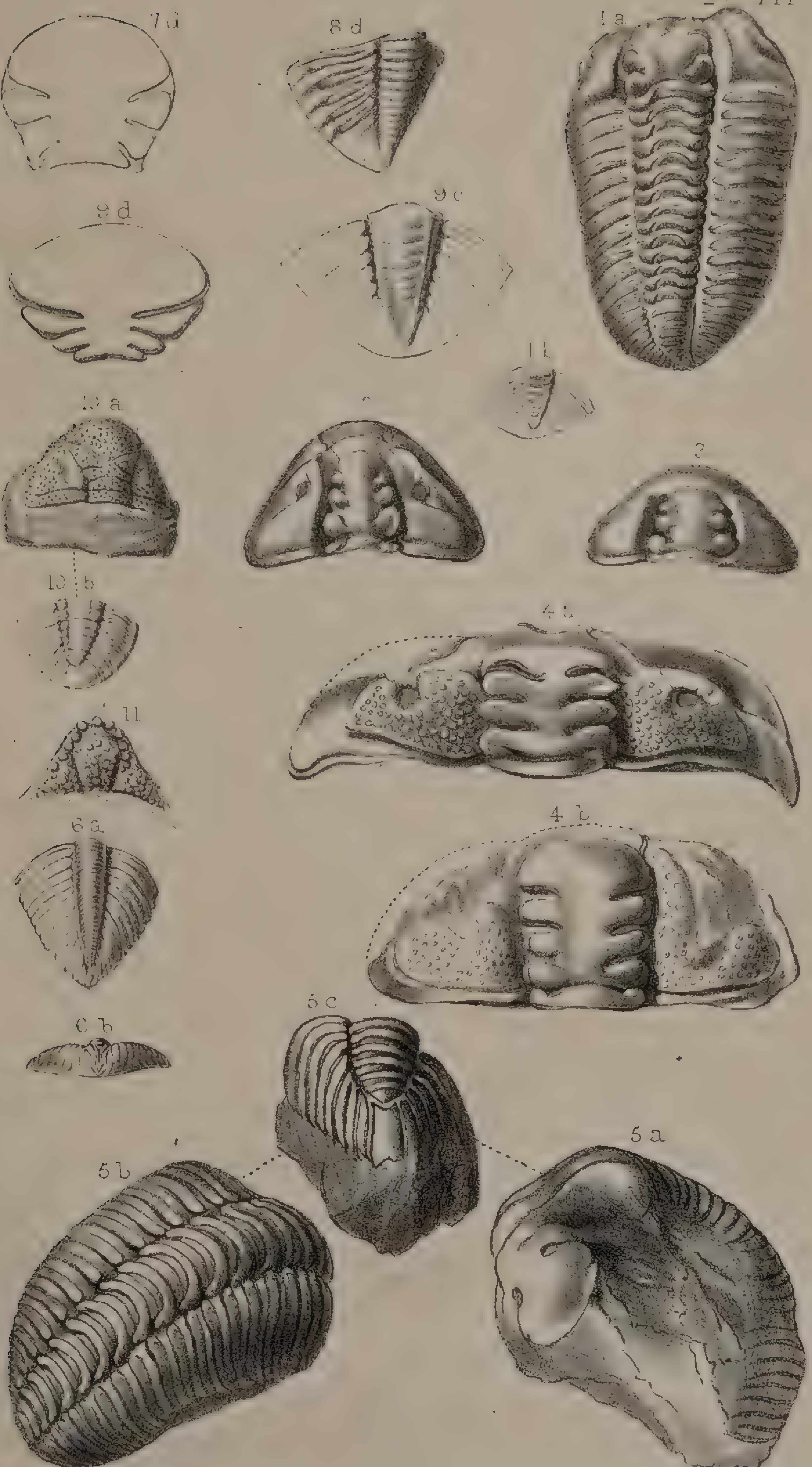


Geo. Du Noyer Delt.

Pl. III



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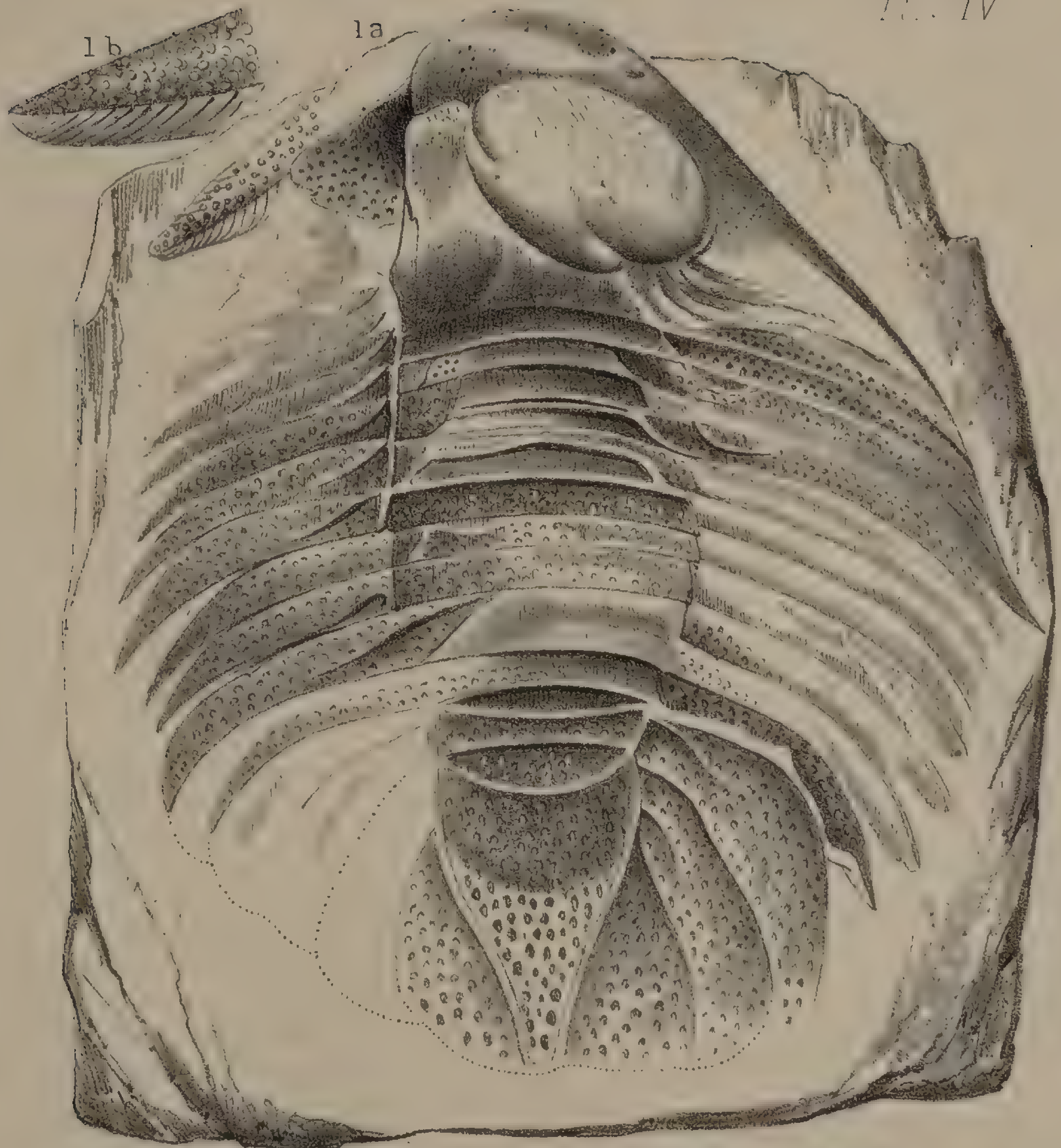
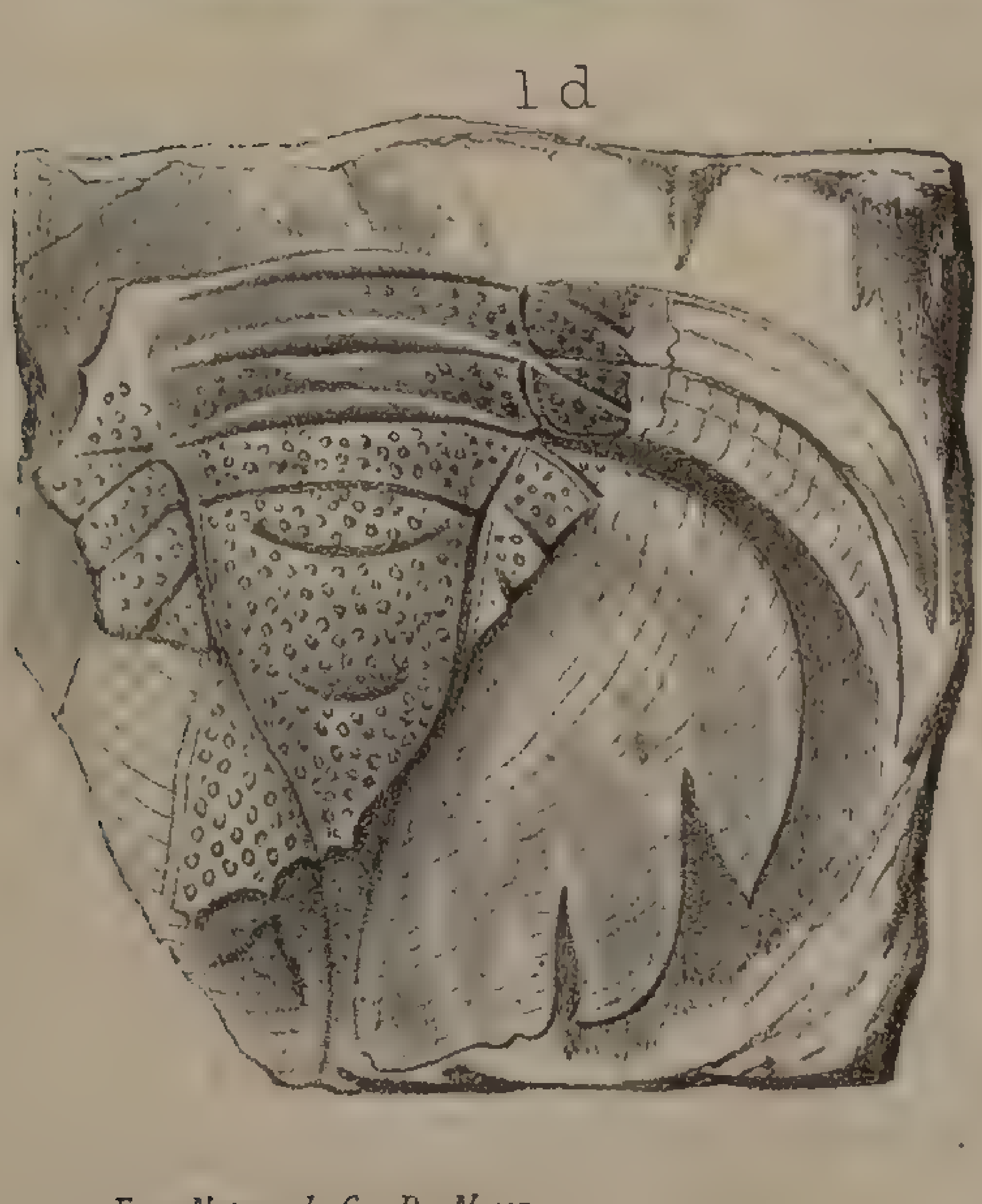
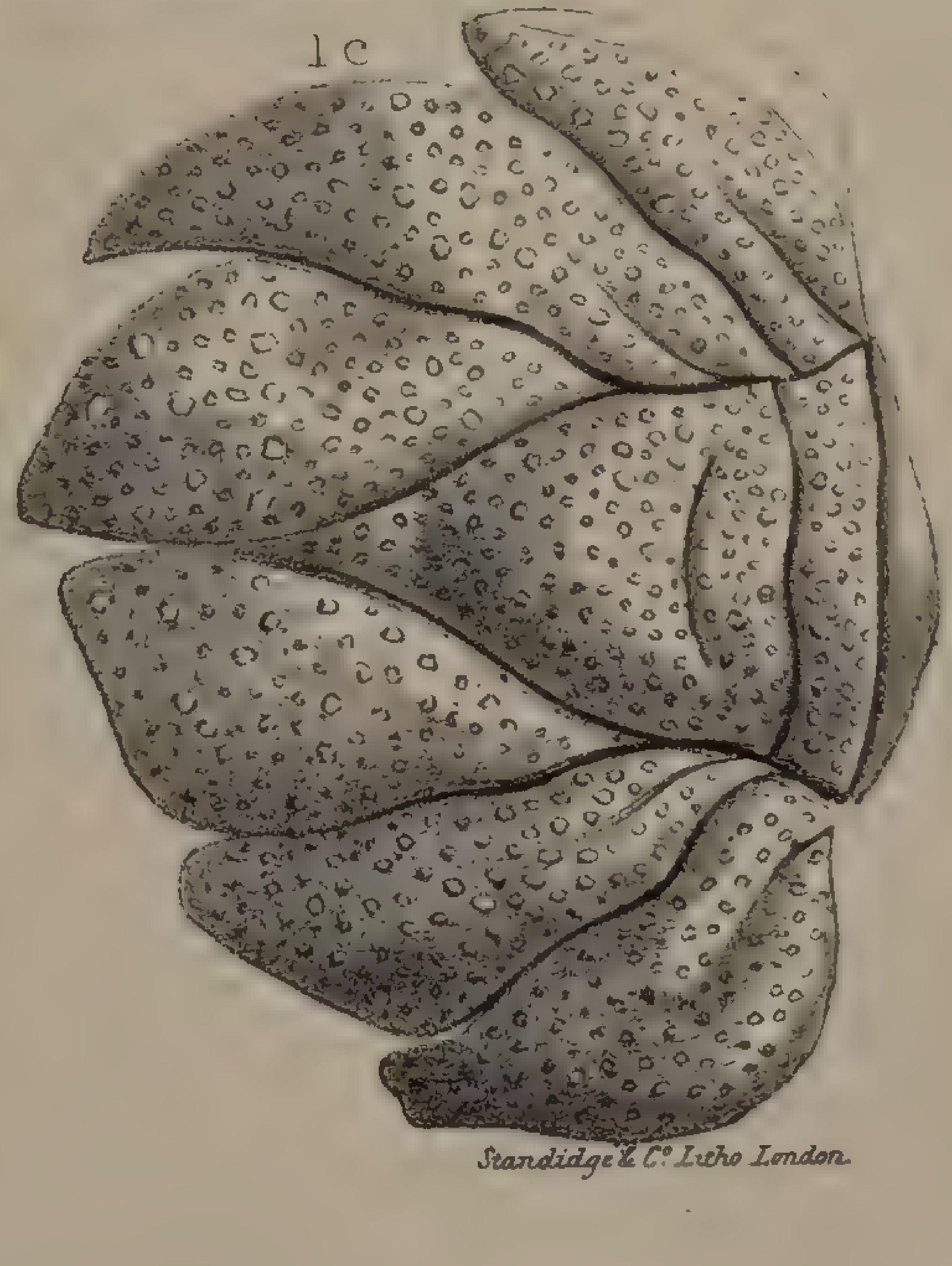
Pl. IV







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Pl V

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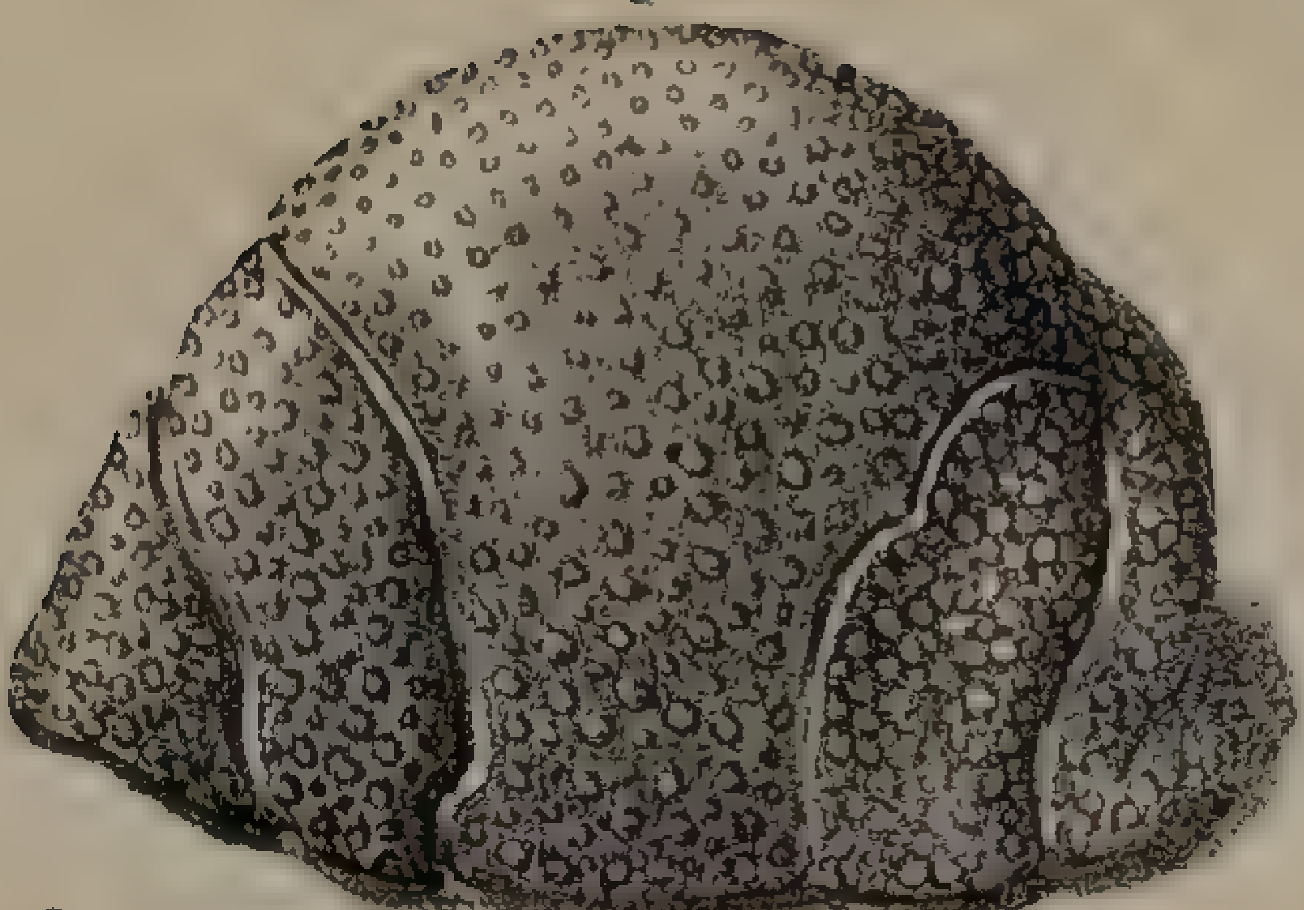

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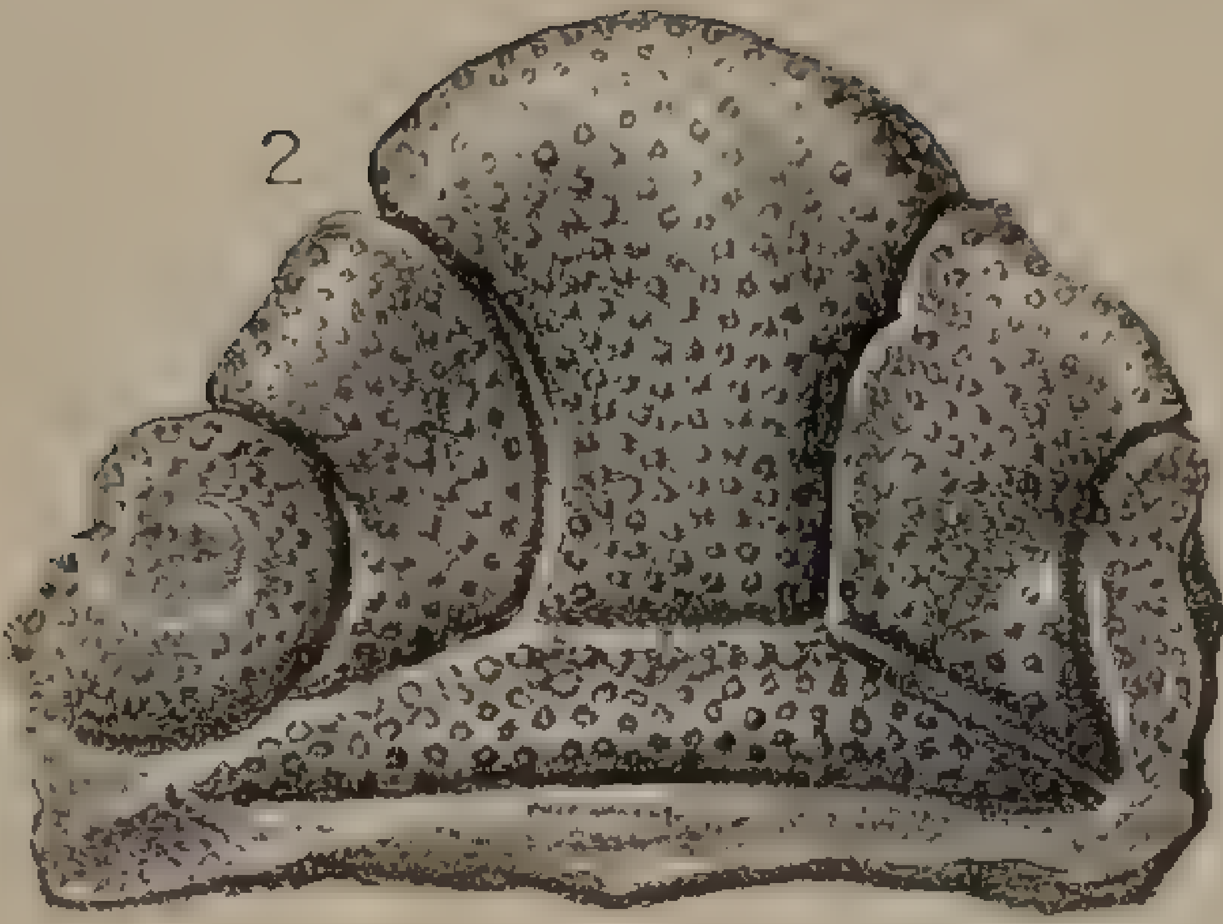

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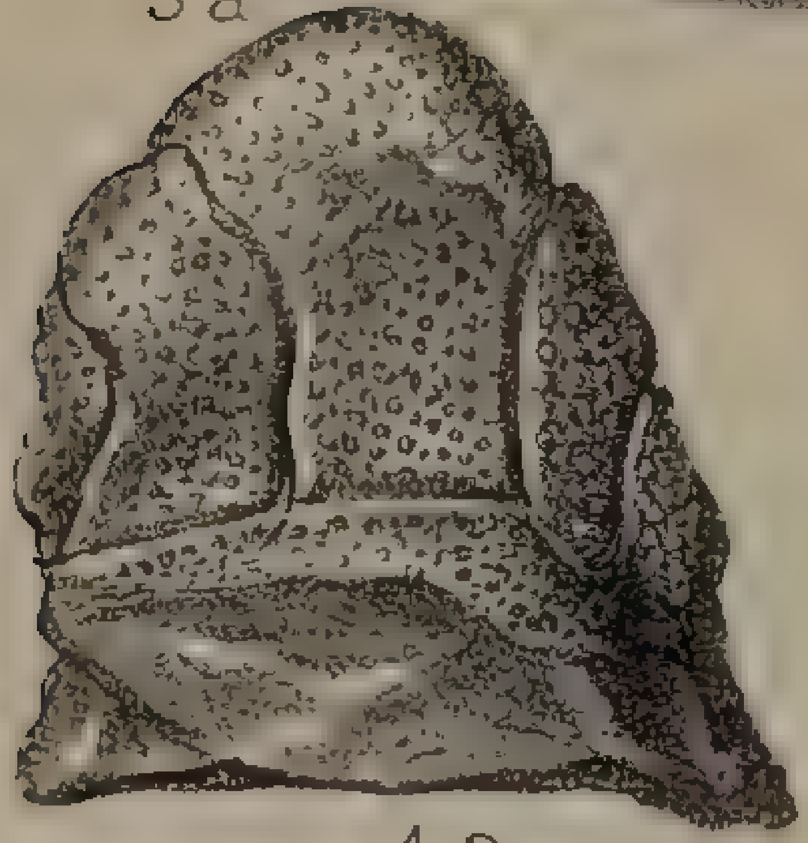

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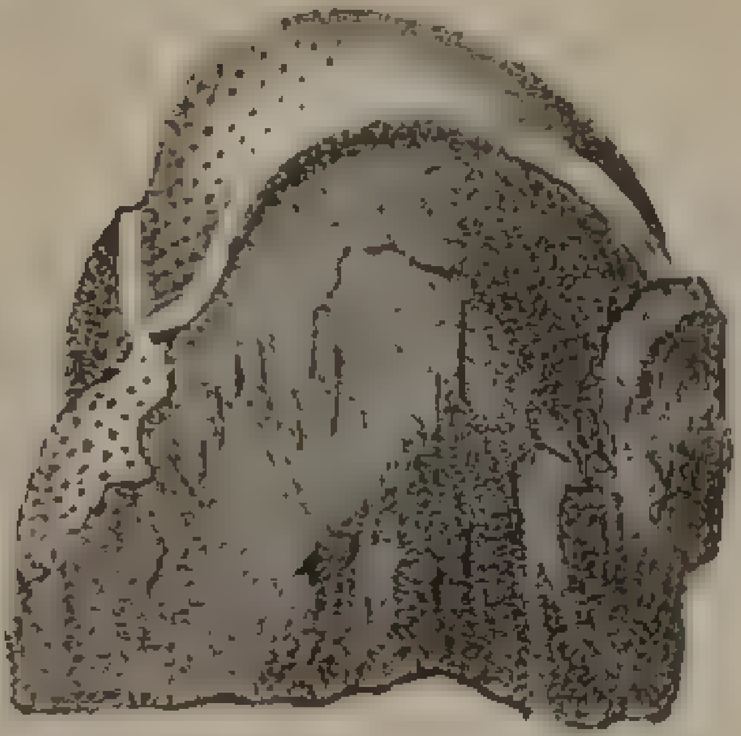

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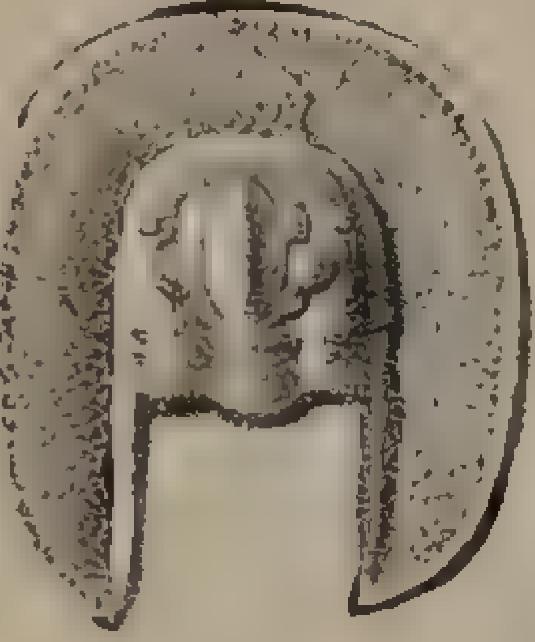

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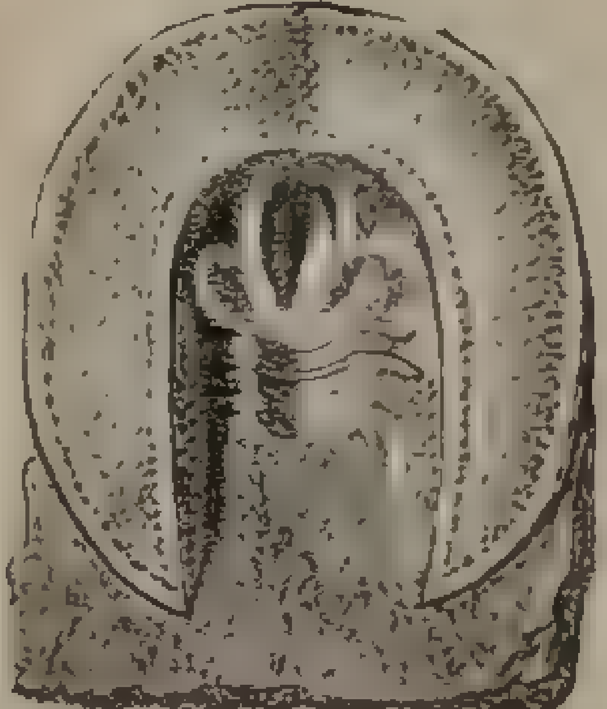

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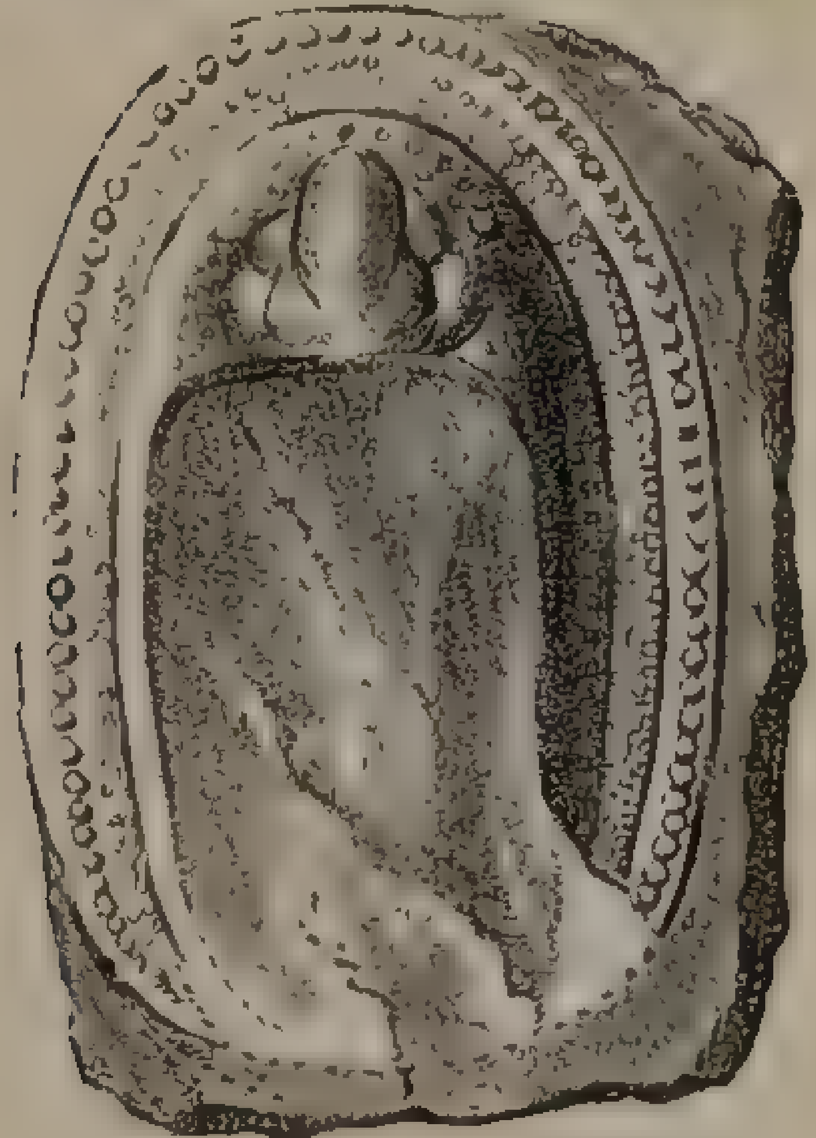

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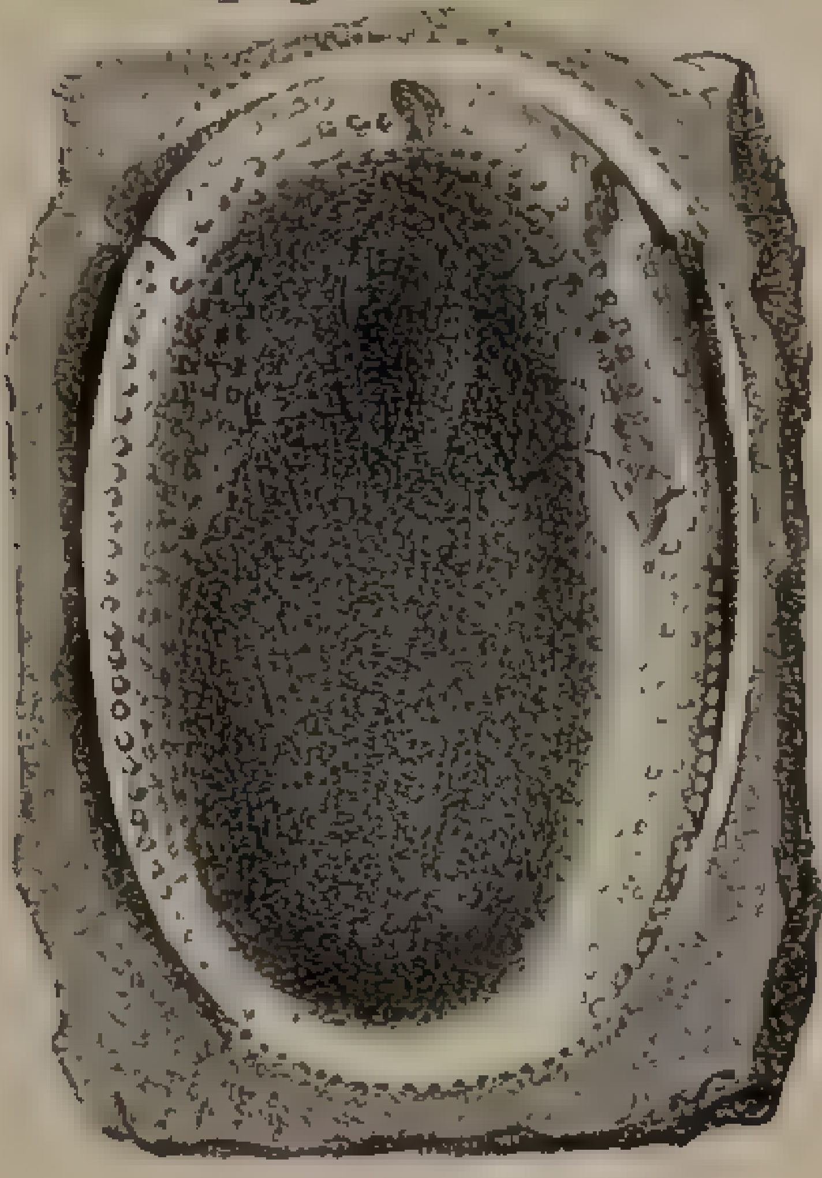

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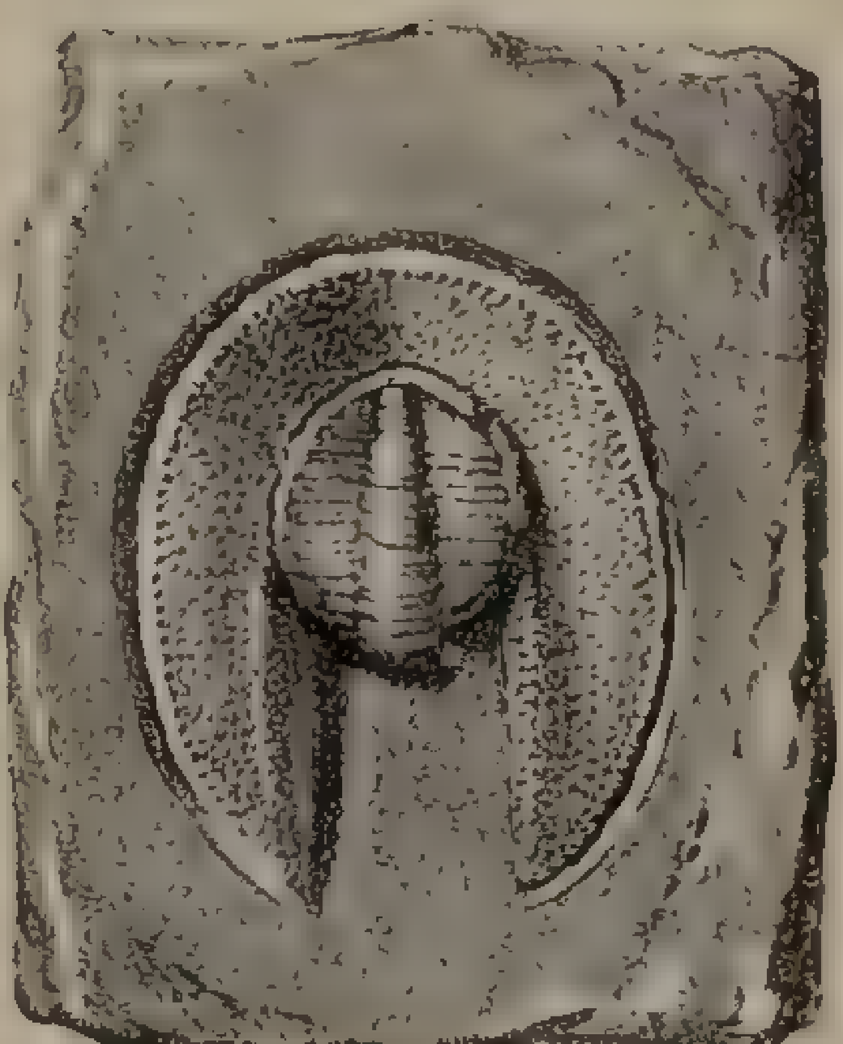

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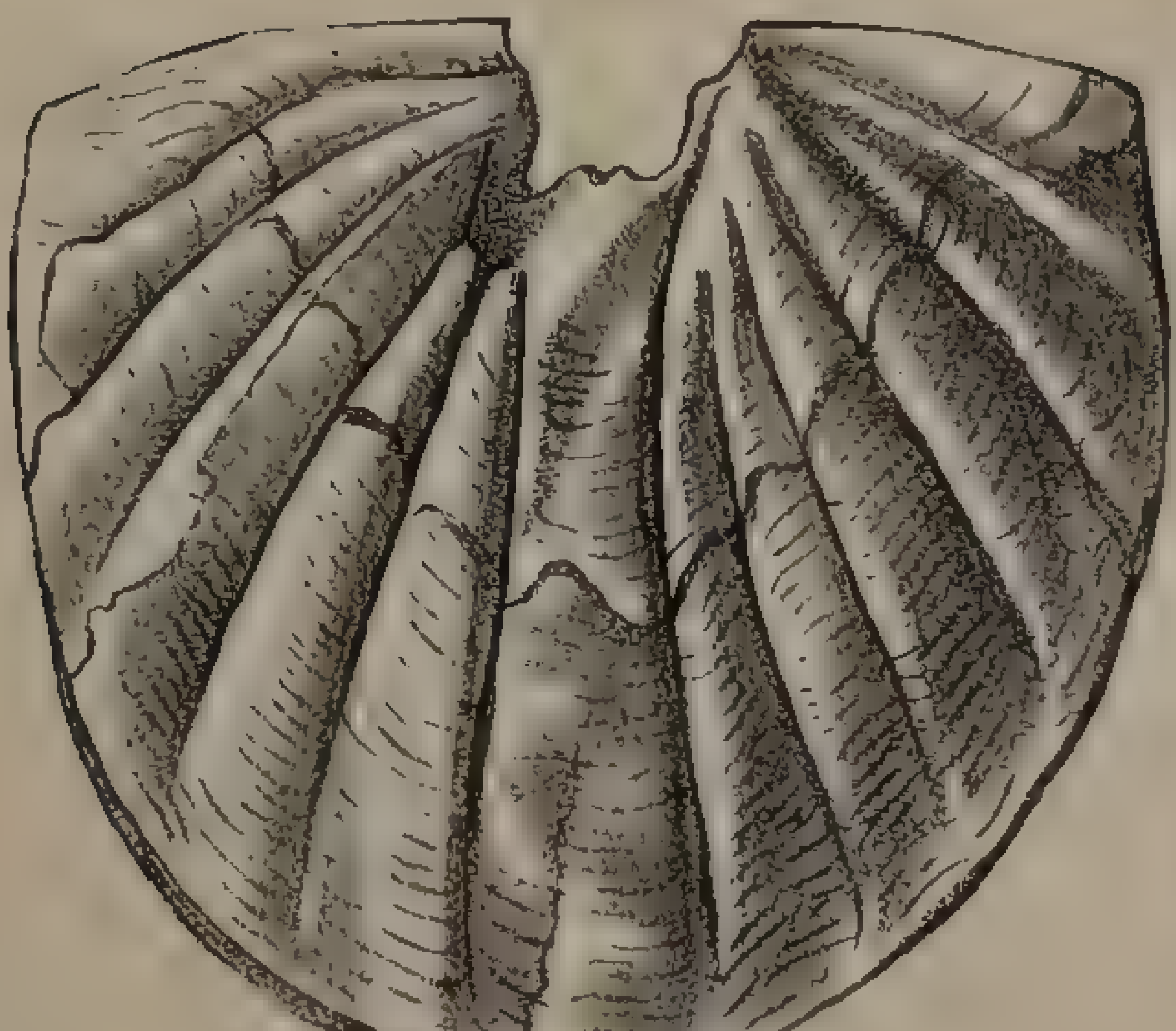

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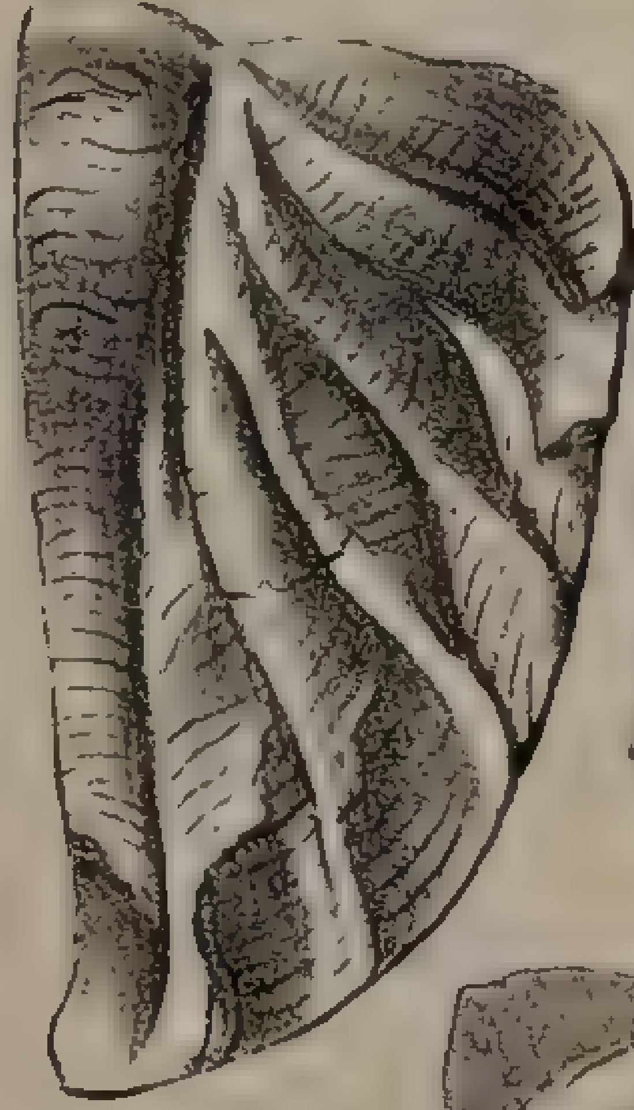

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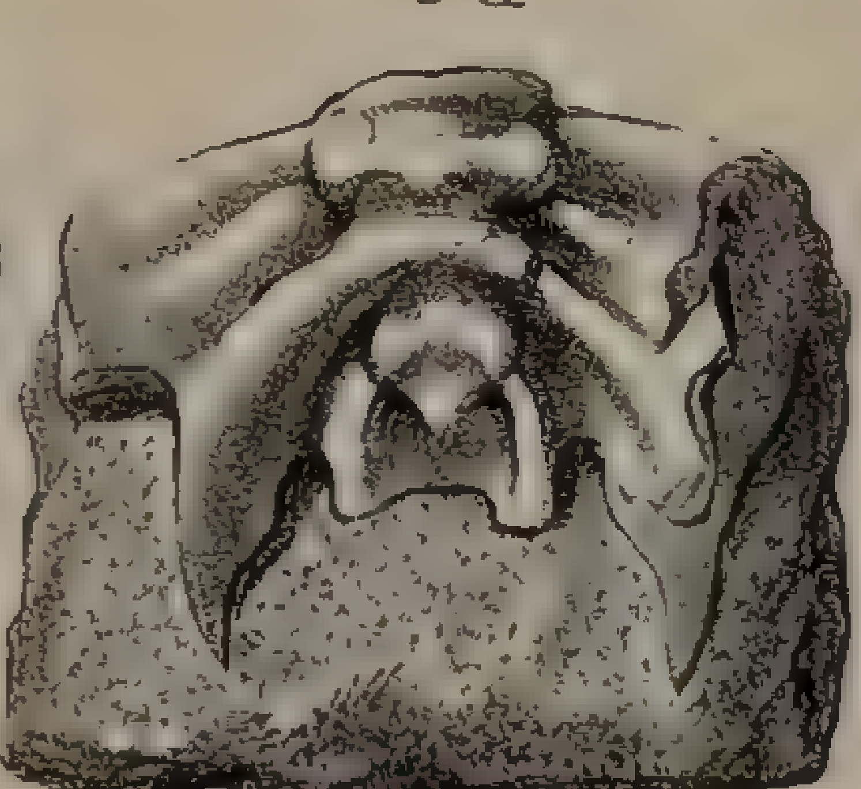

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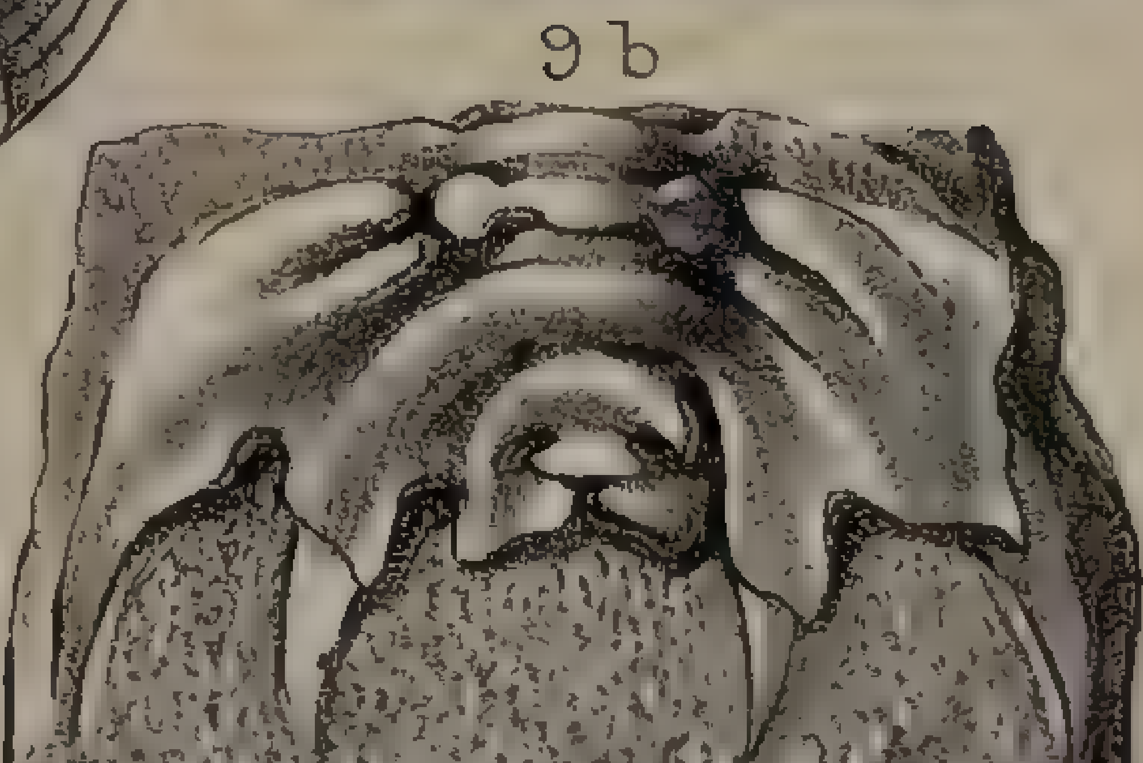

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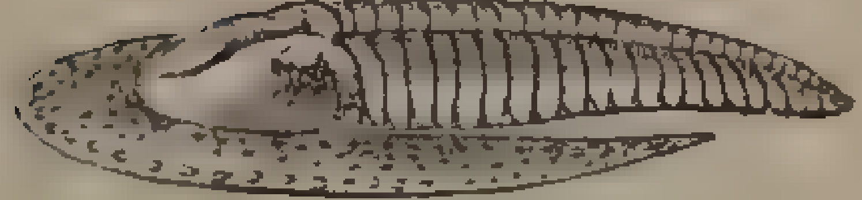

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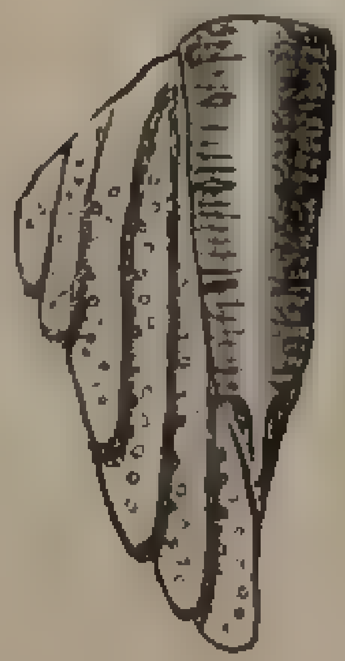

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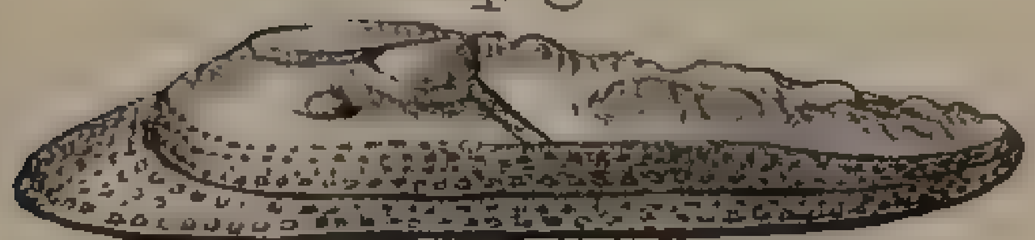

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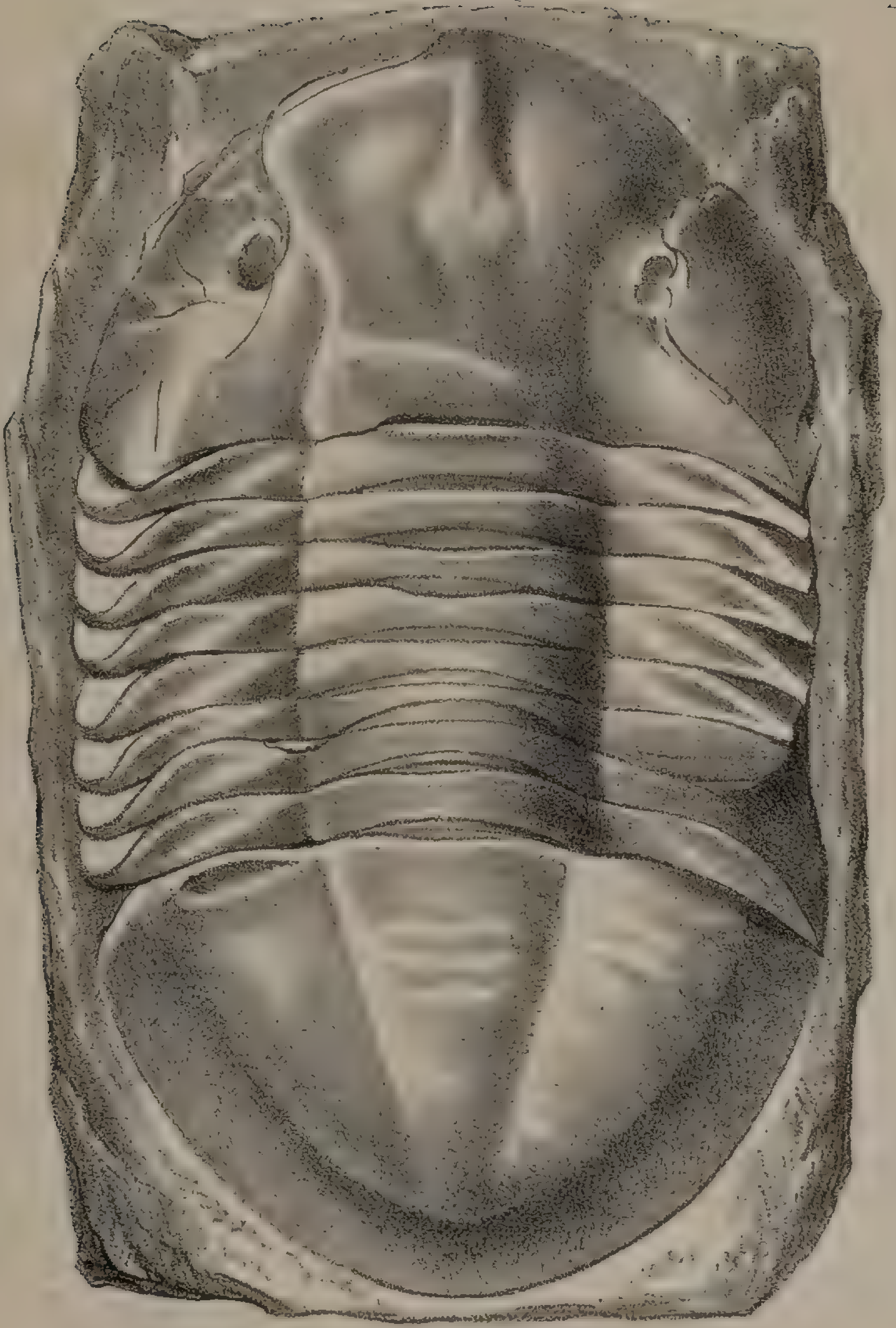

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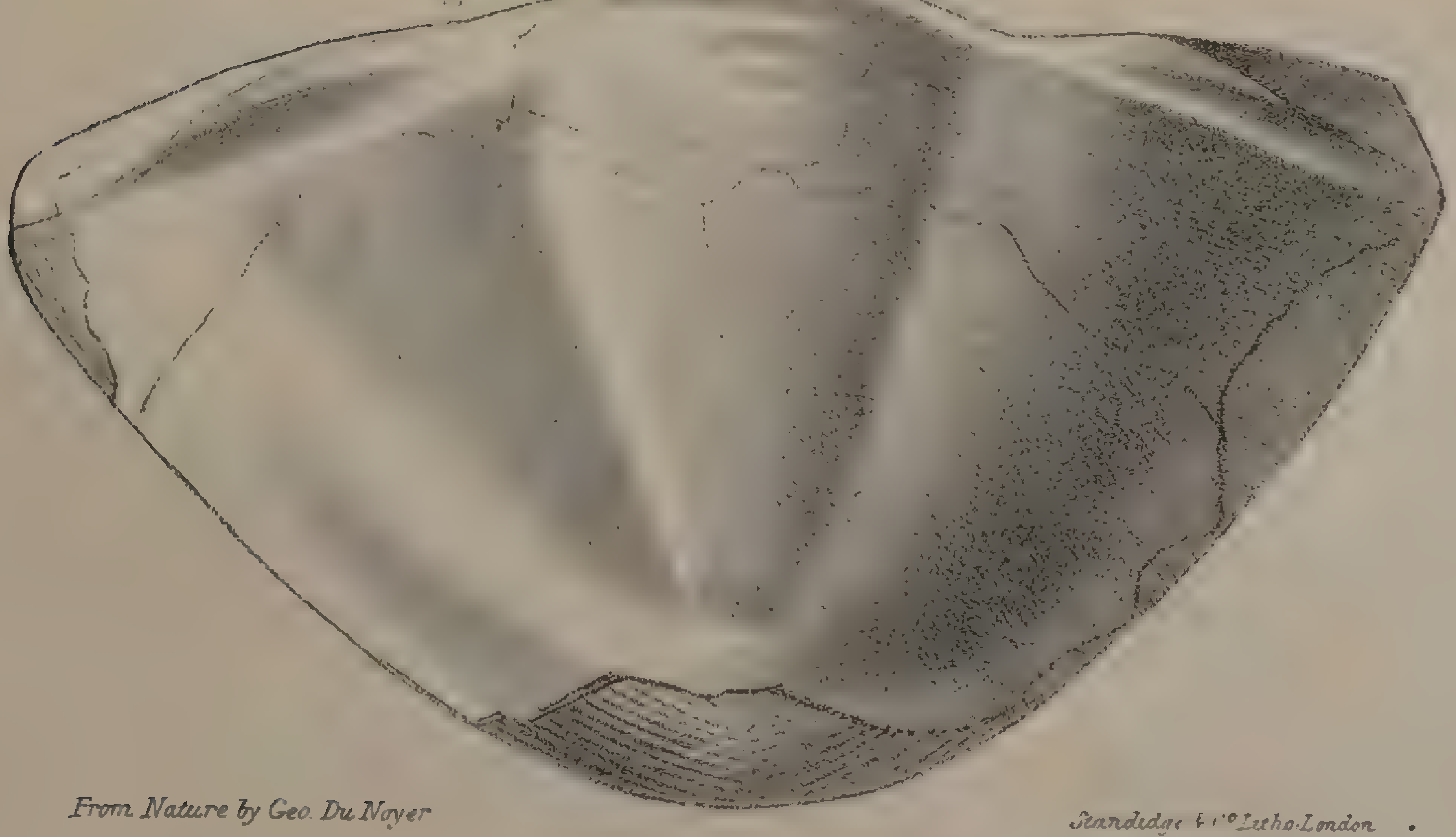

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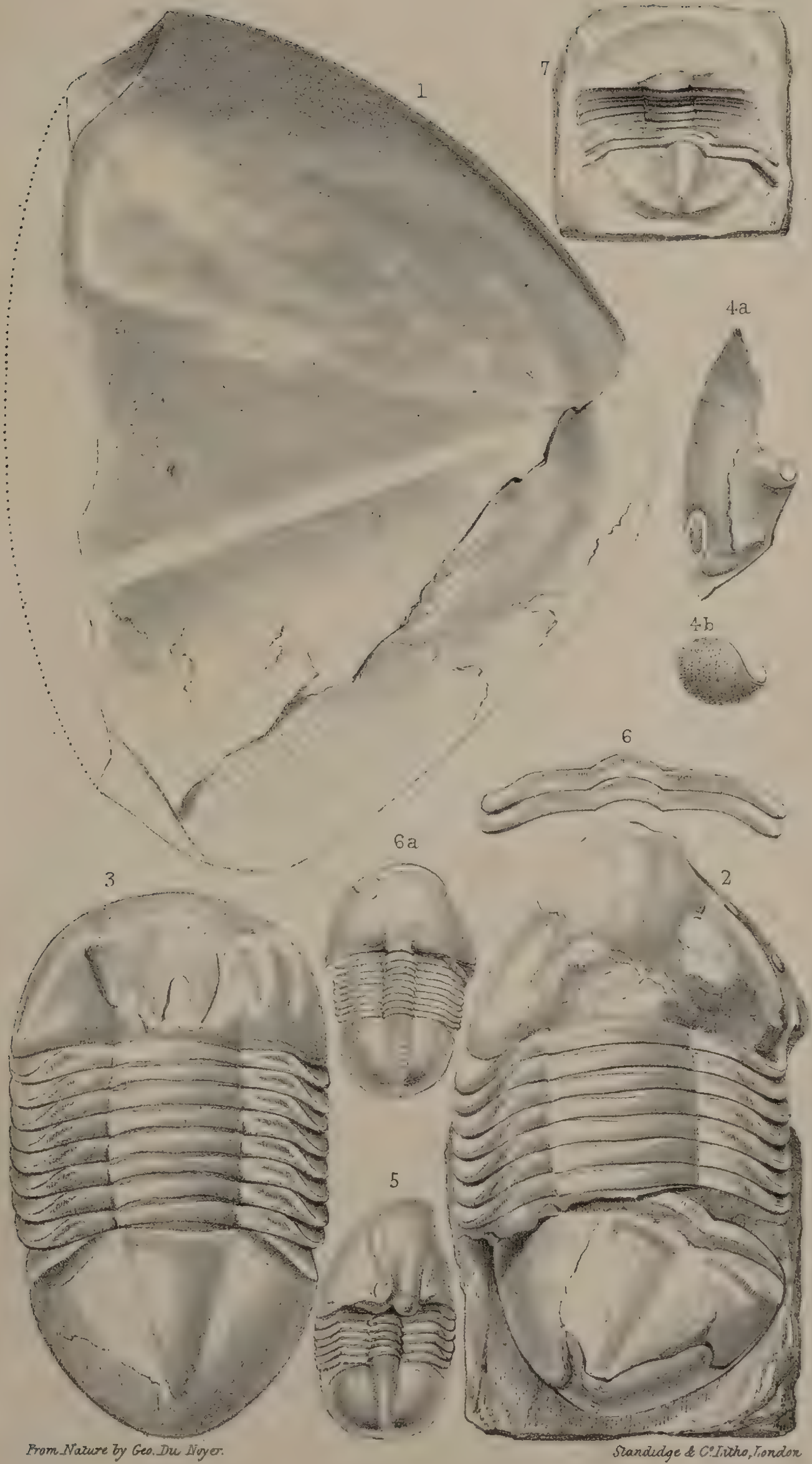
Pl. VII.



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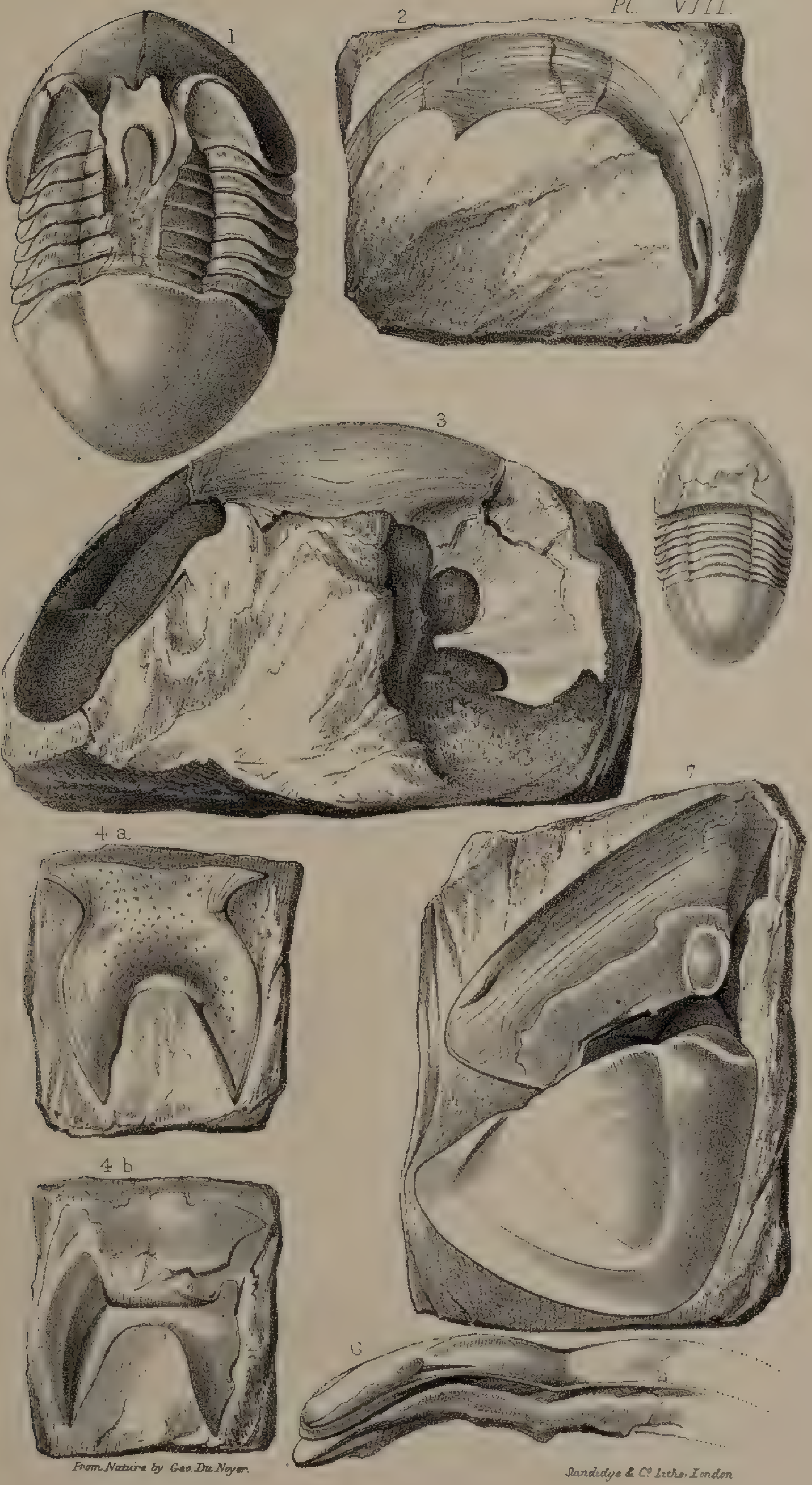
Pl. VIII.



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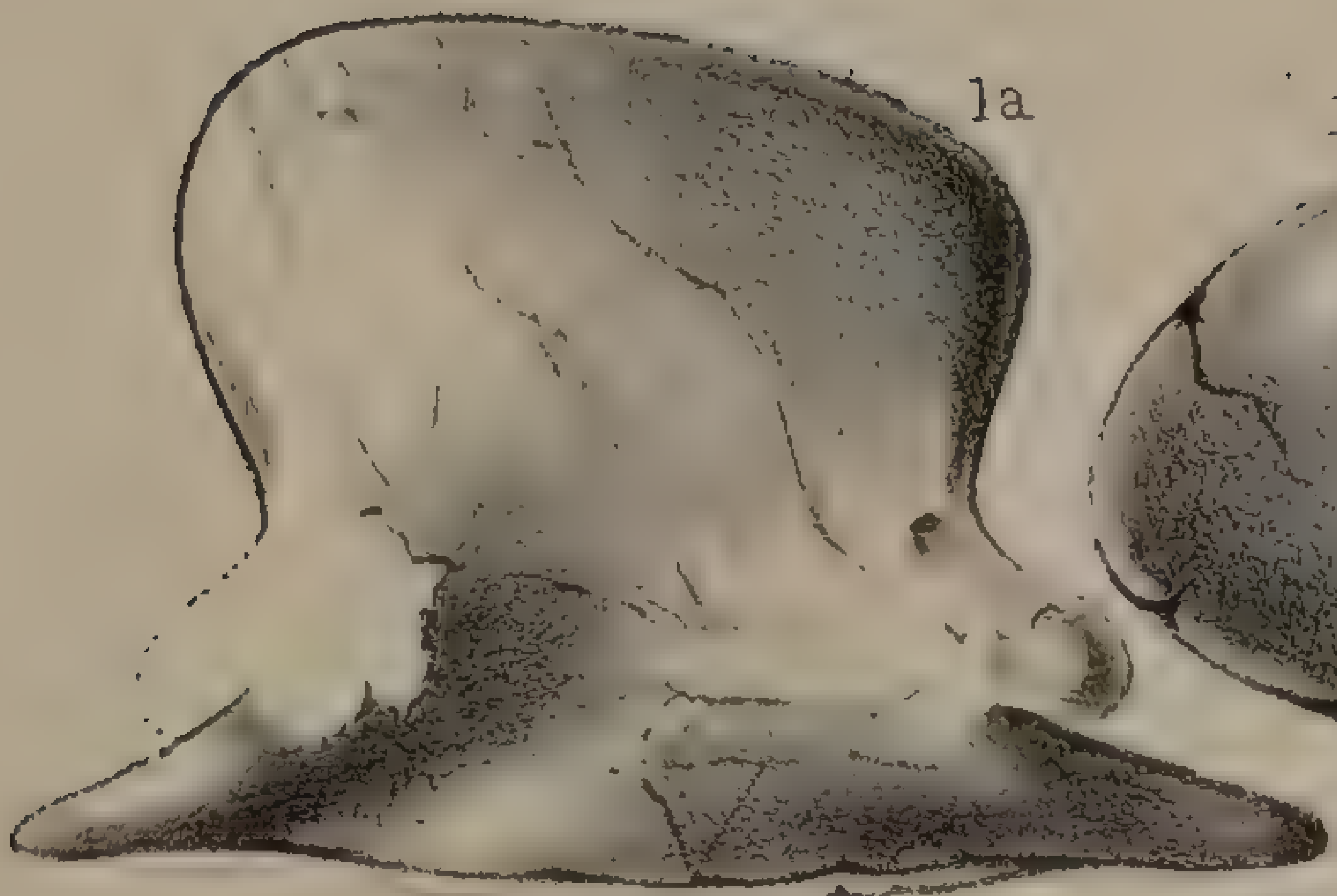
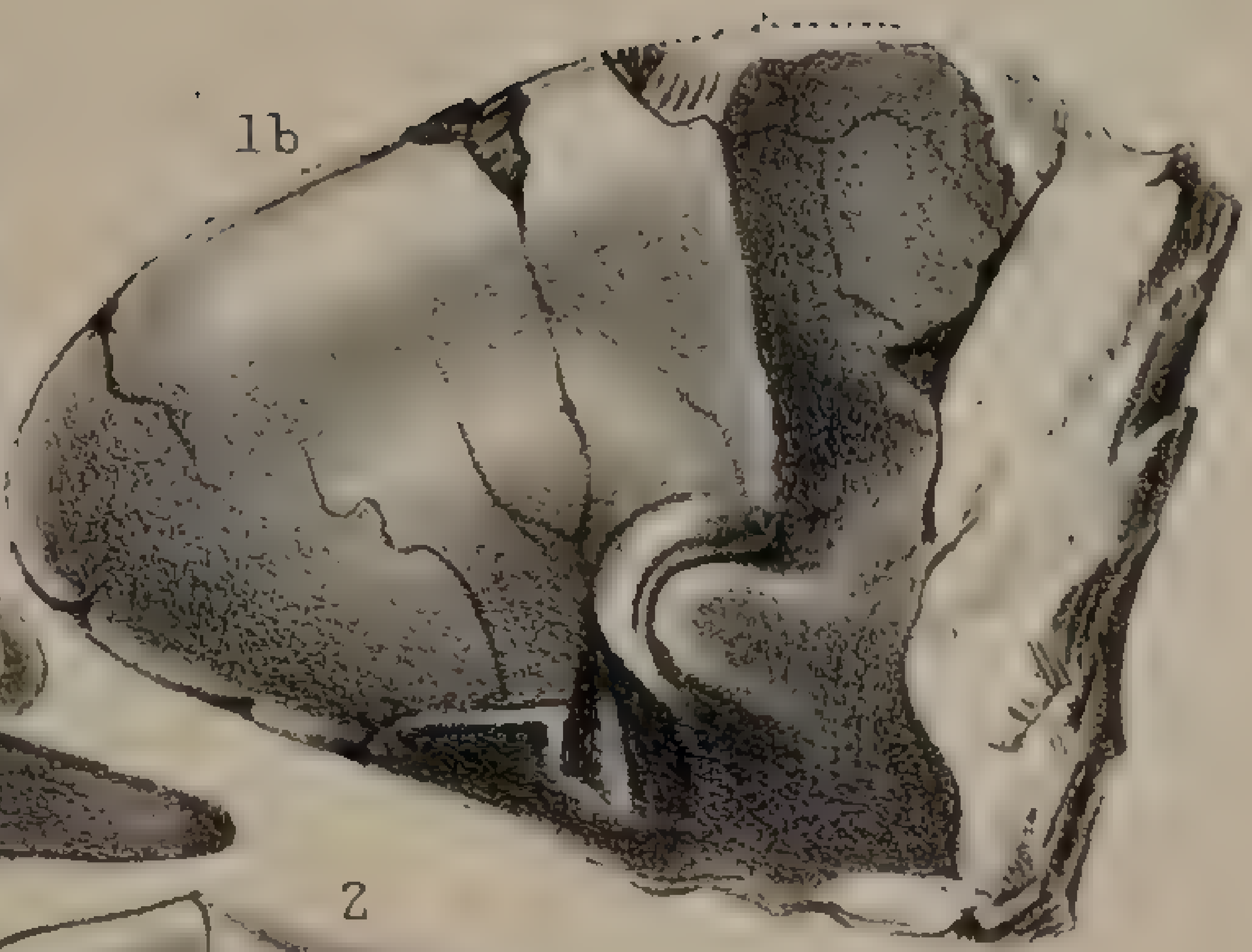
1a



1b



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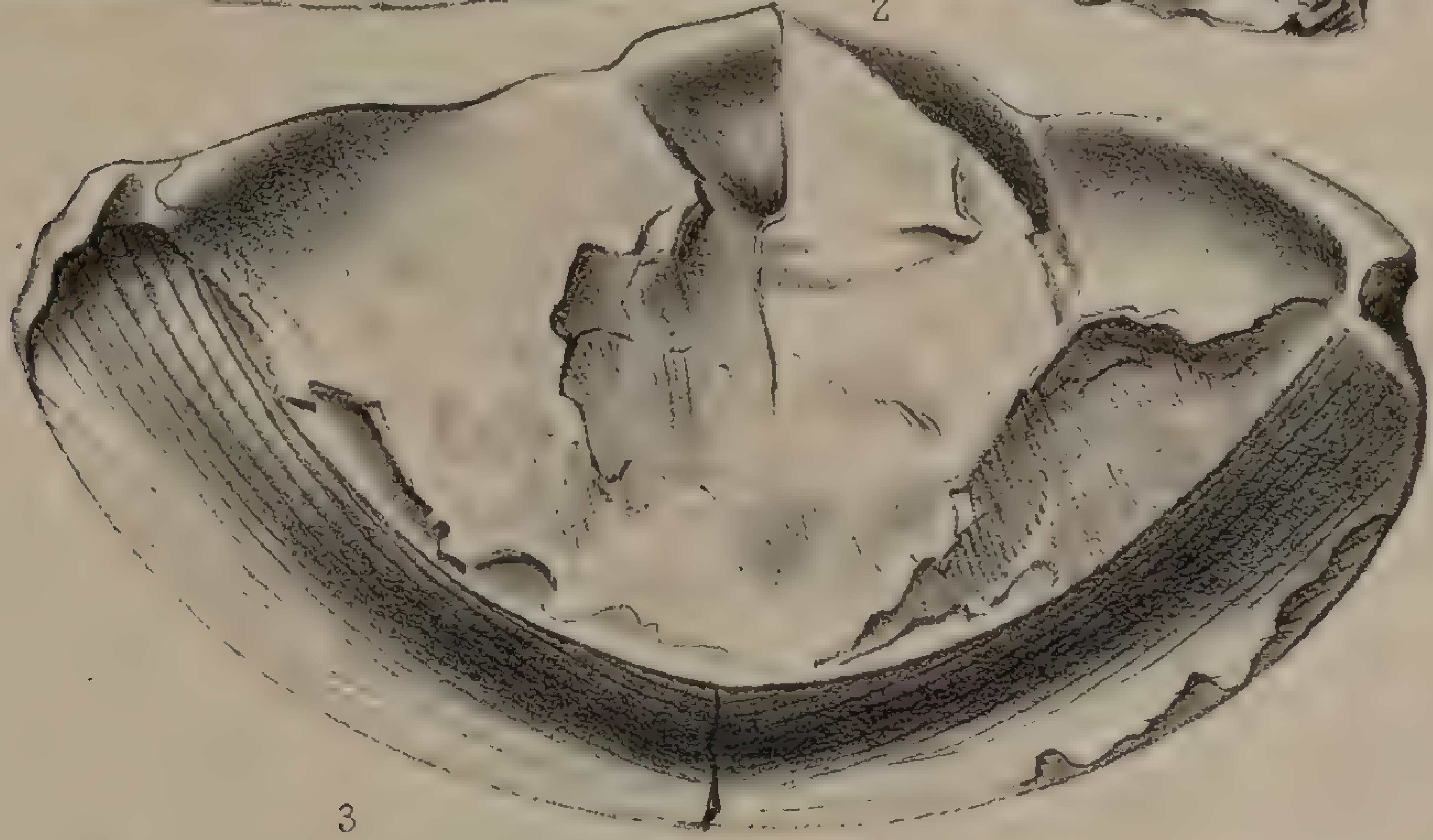

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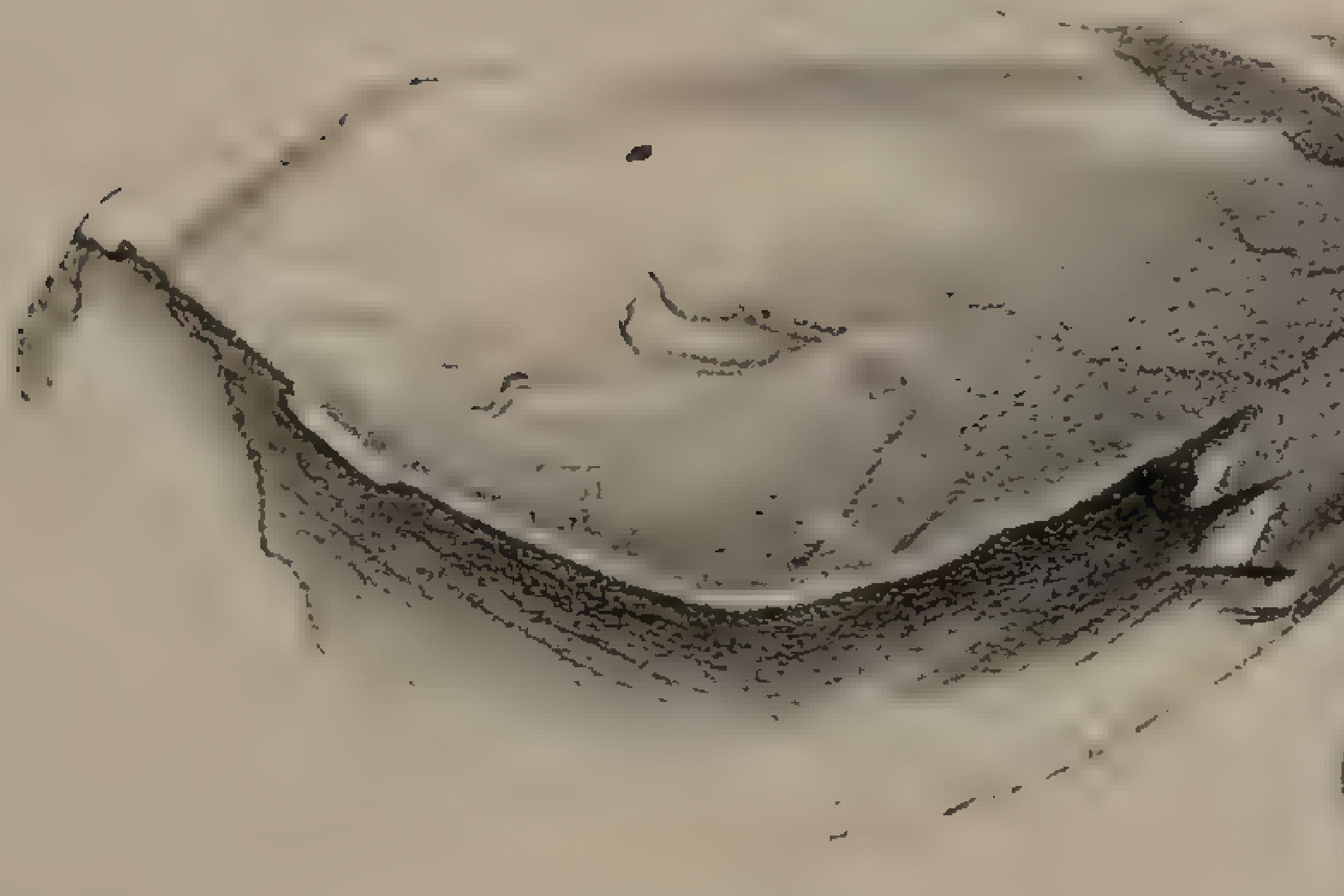

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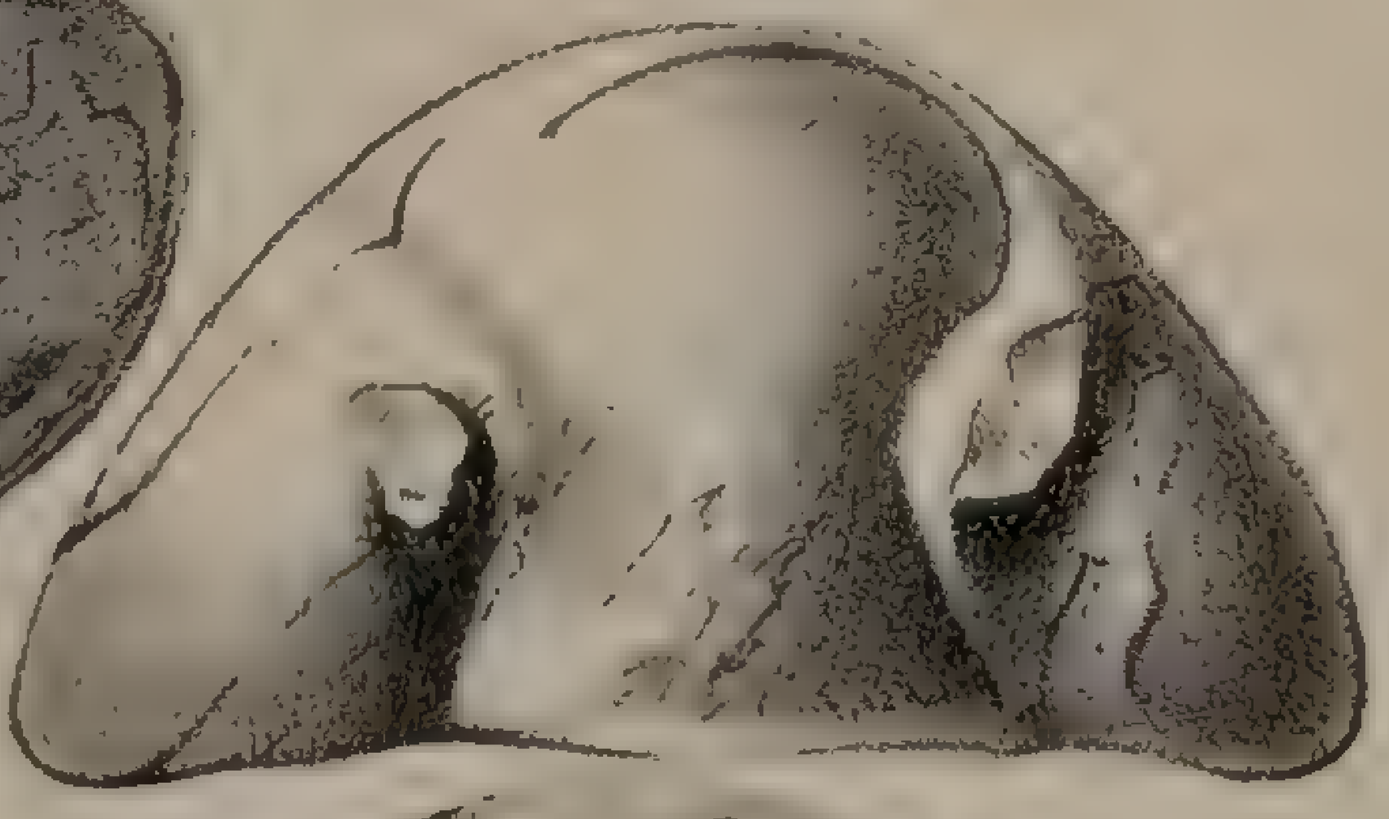

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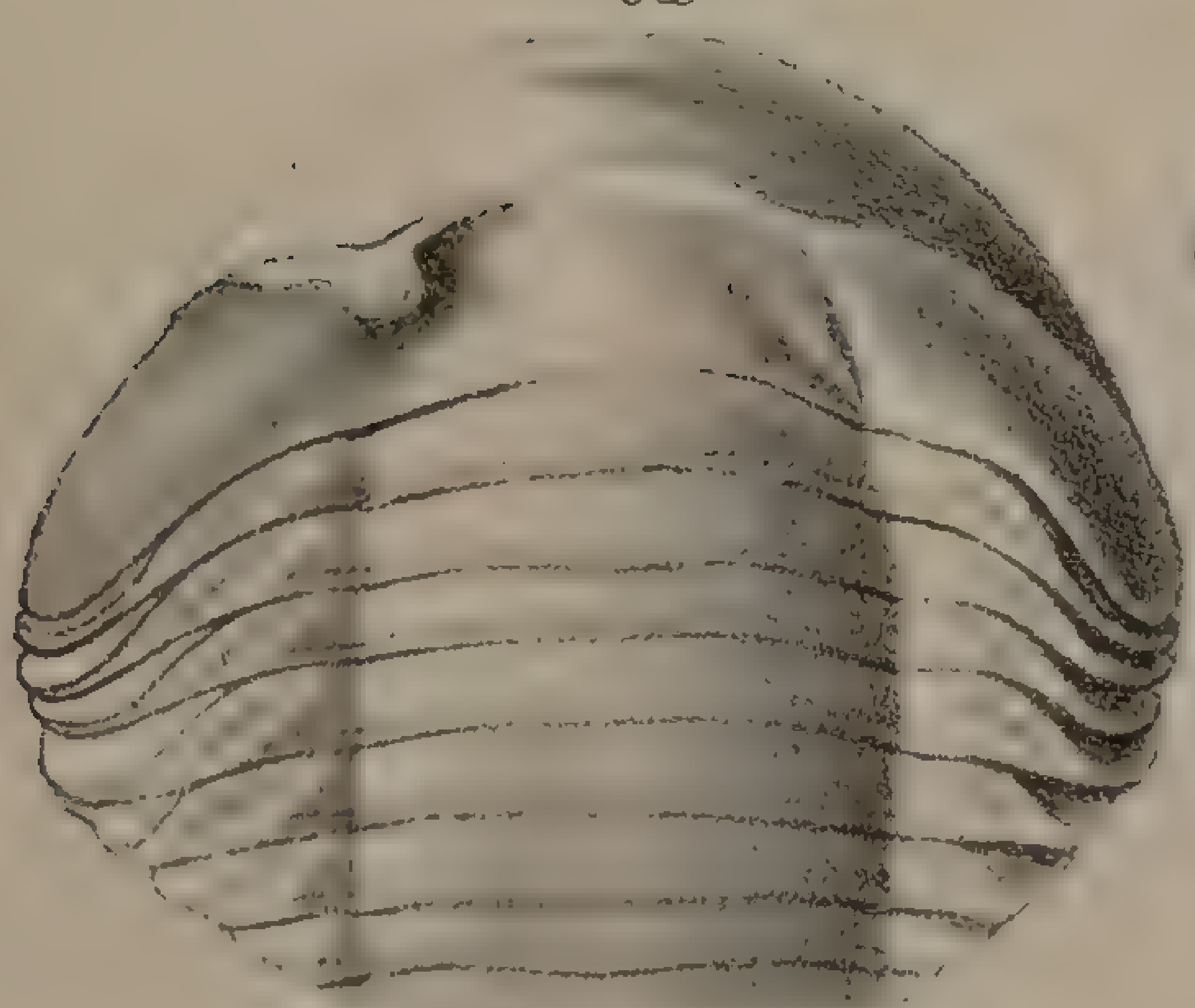

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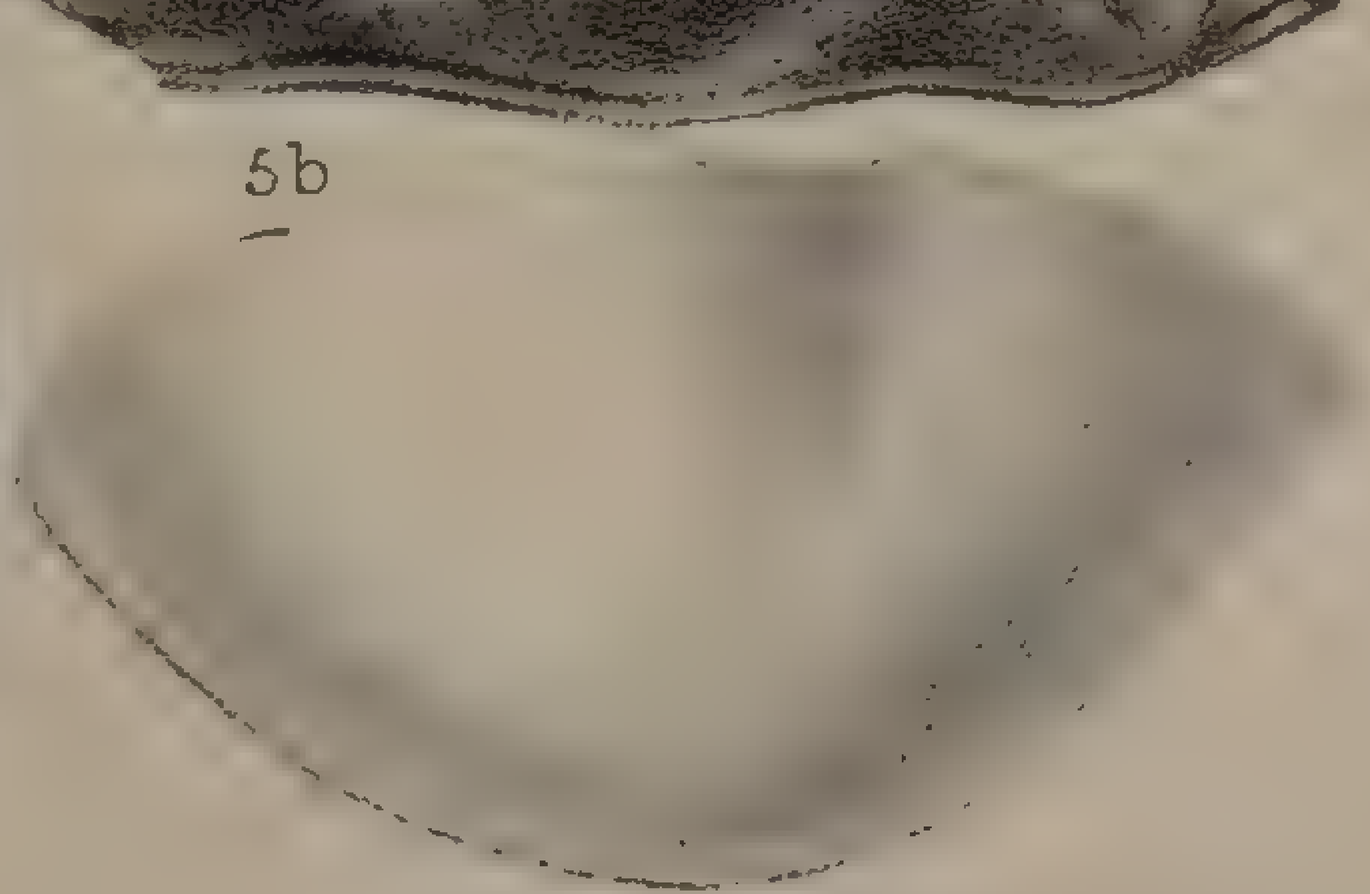

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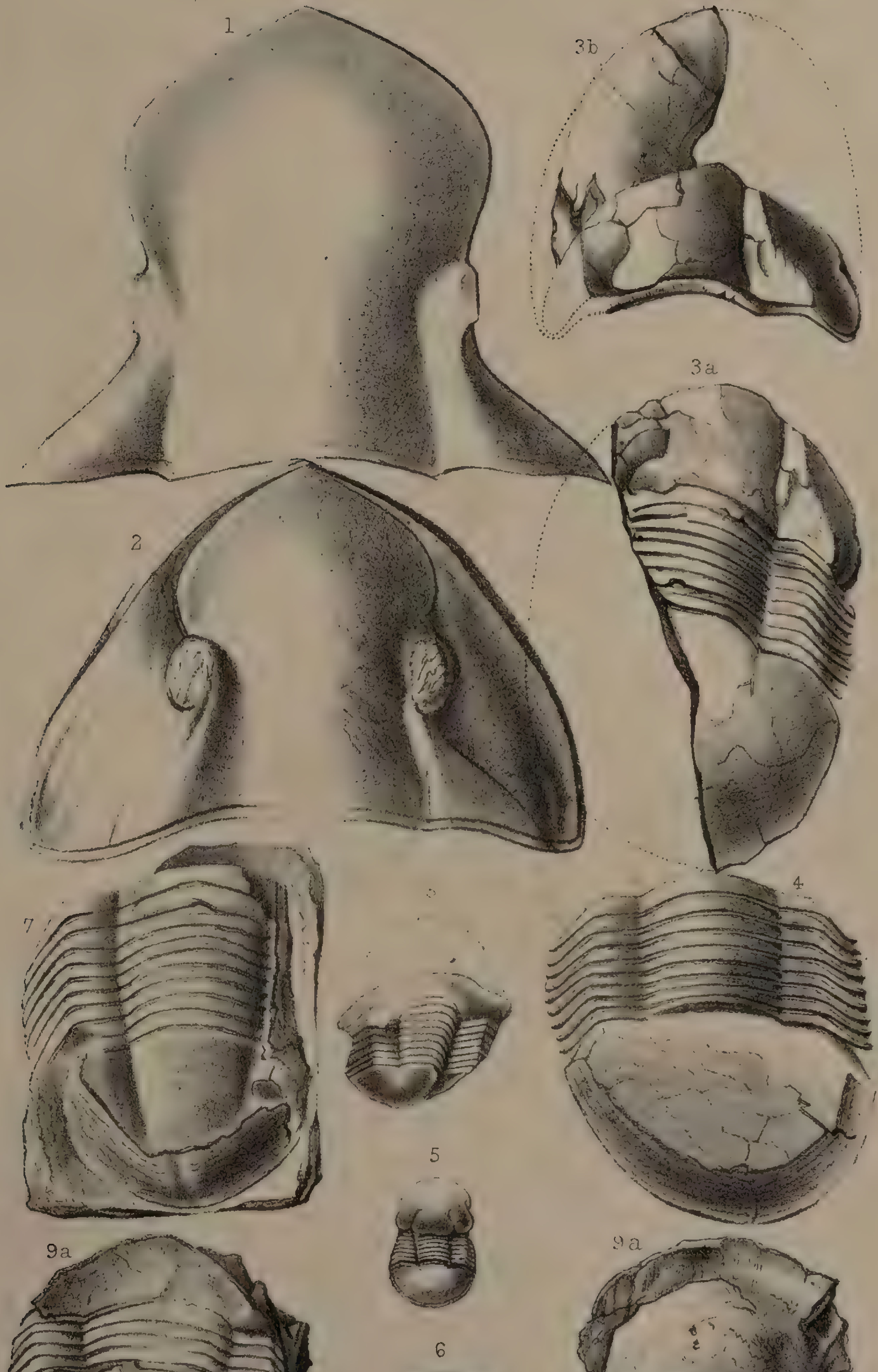
Pl. X.



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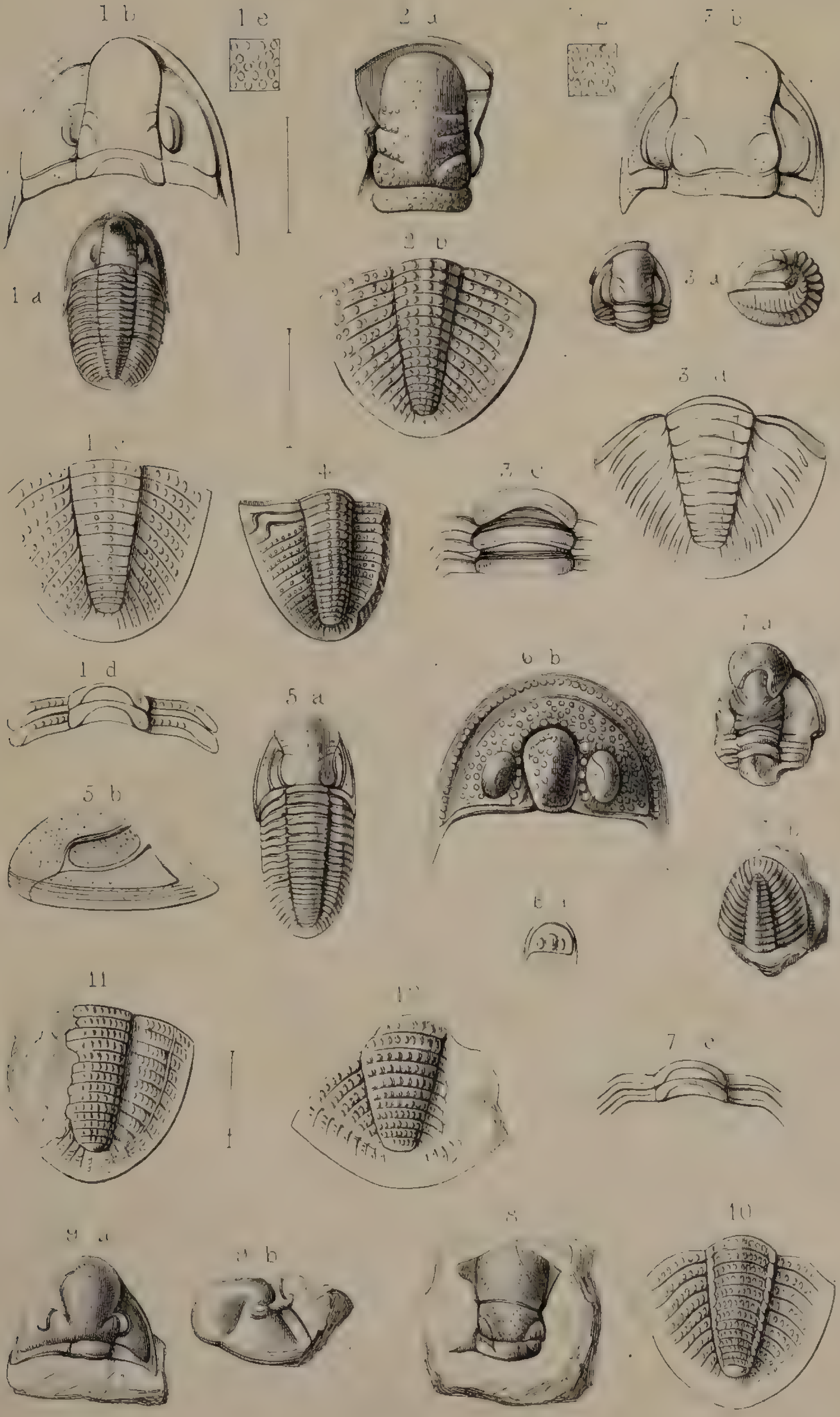
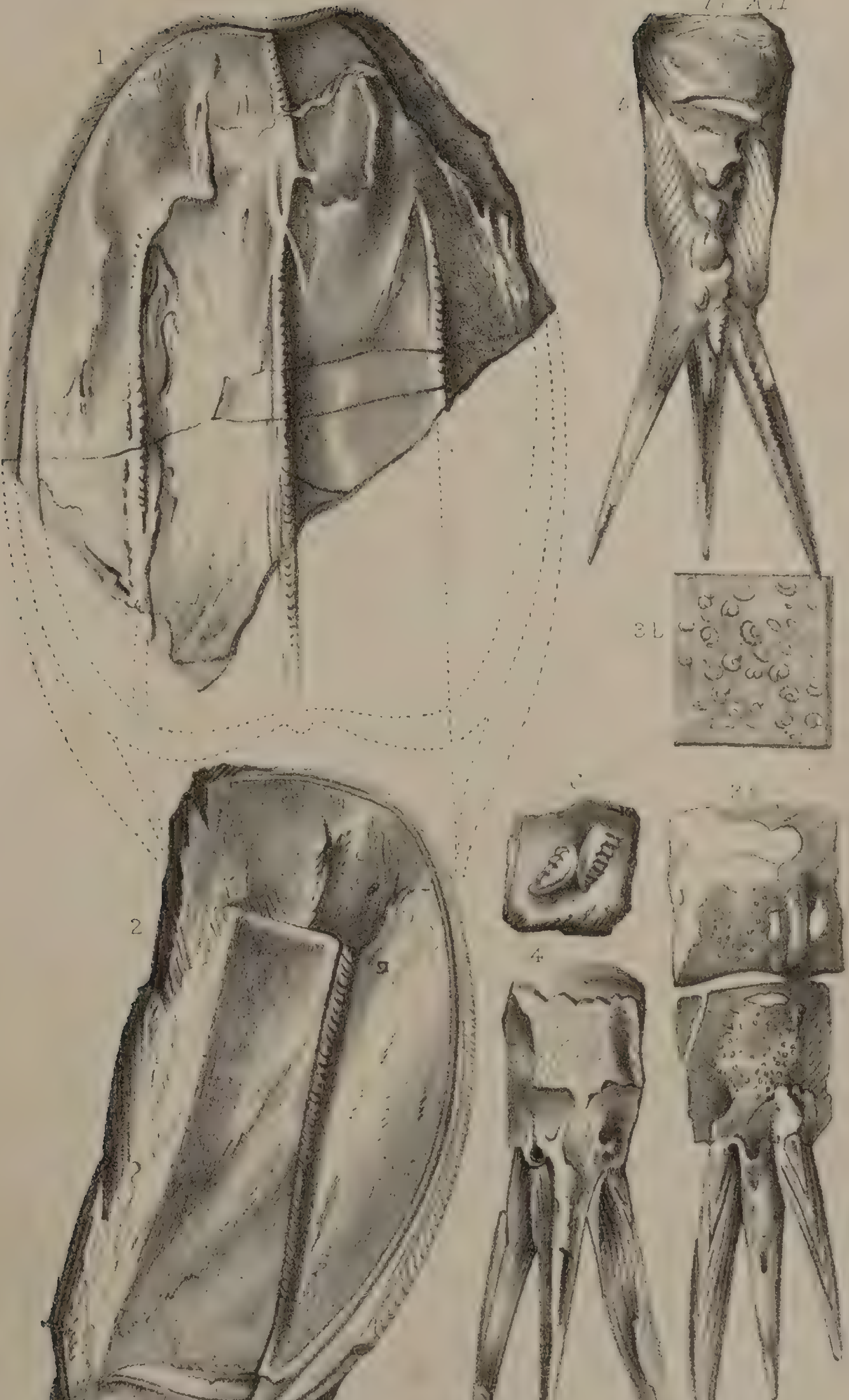
Pl. XI.



Geo. Du Noyer Delt.

Standidge & Co. Litho. London.

Pl. XII



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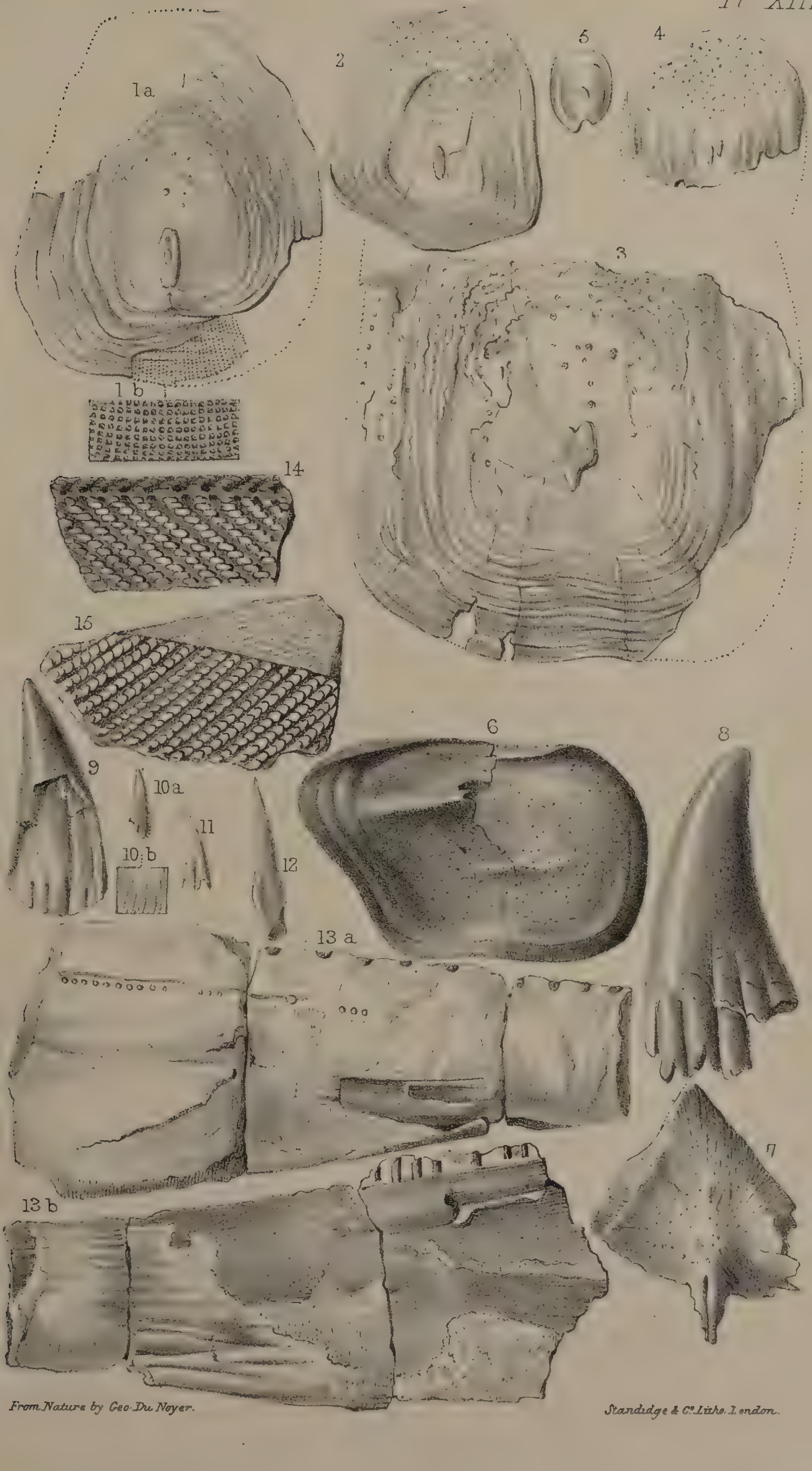
Pl XIII



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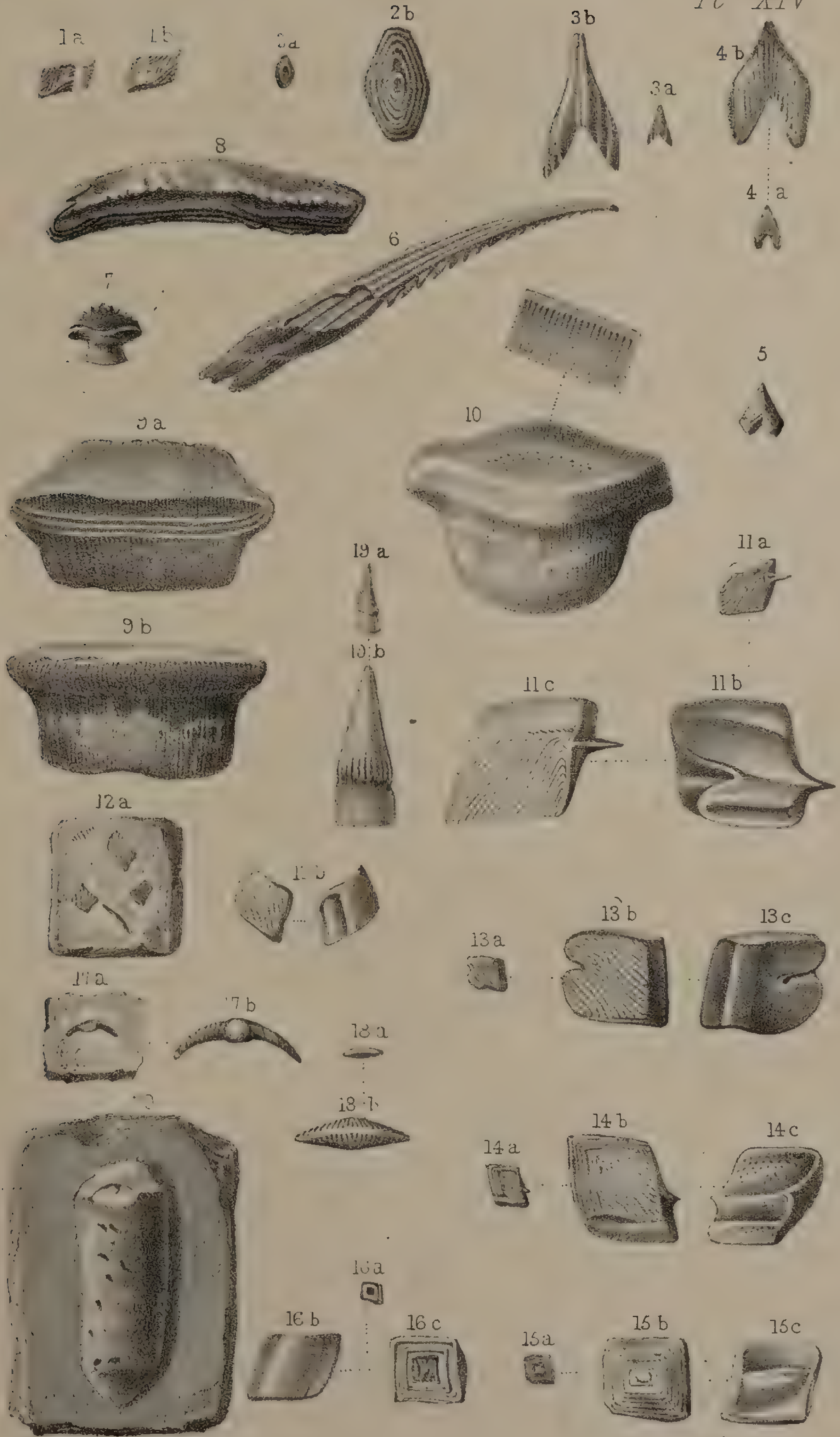
Pl XIV



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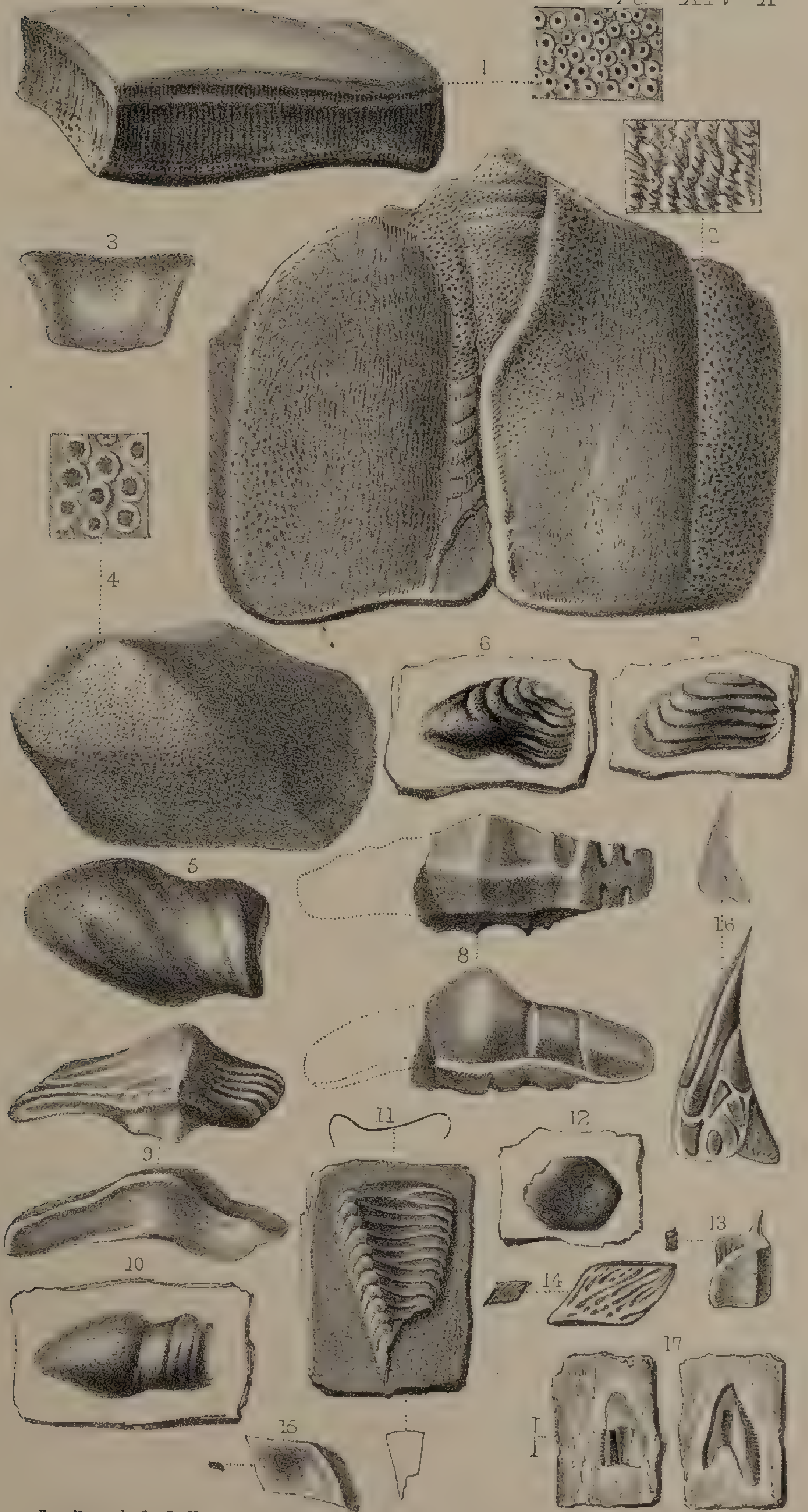
Pl. XIV A



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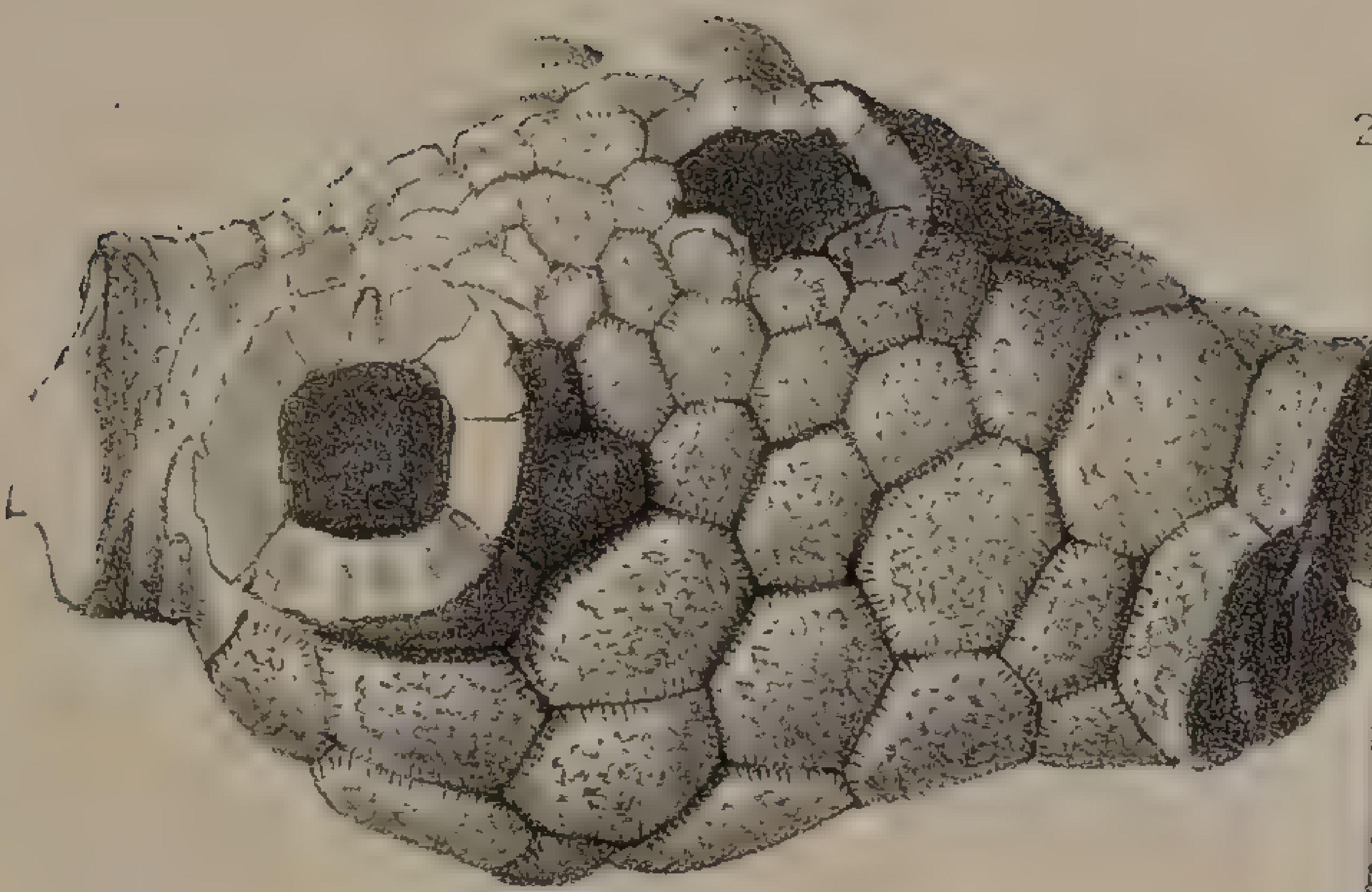
Pl XI.

6



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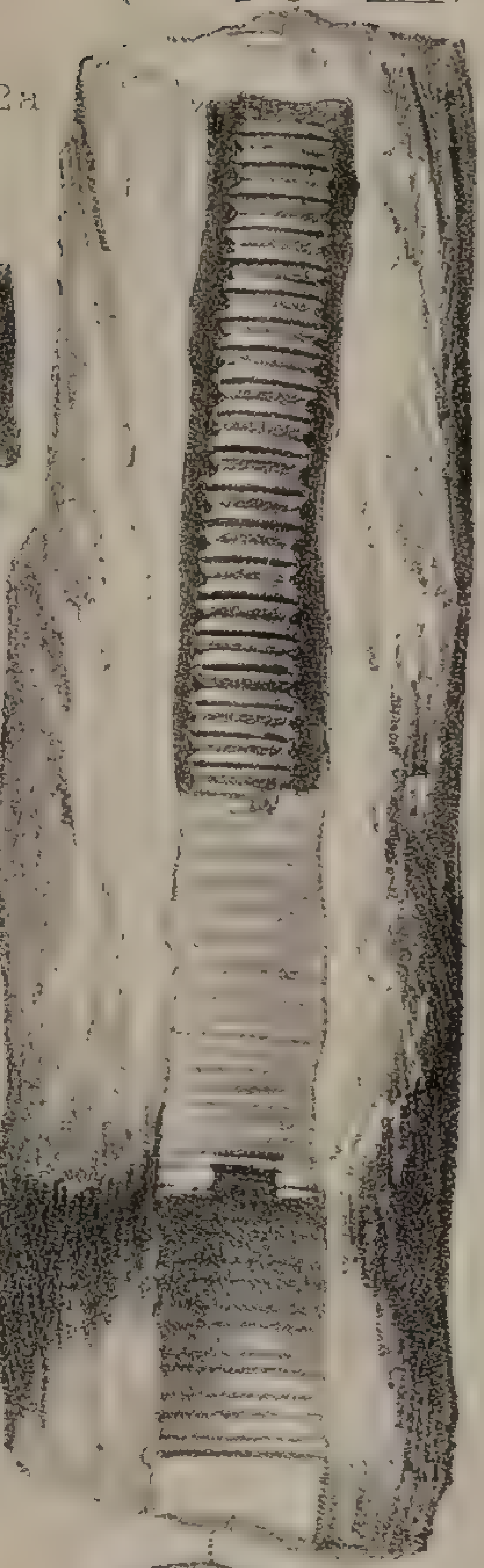

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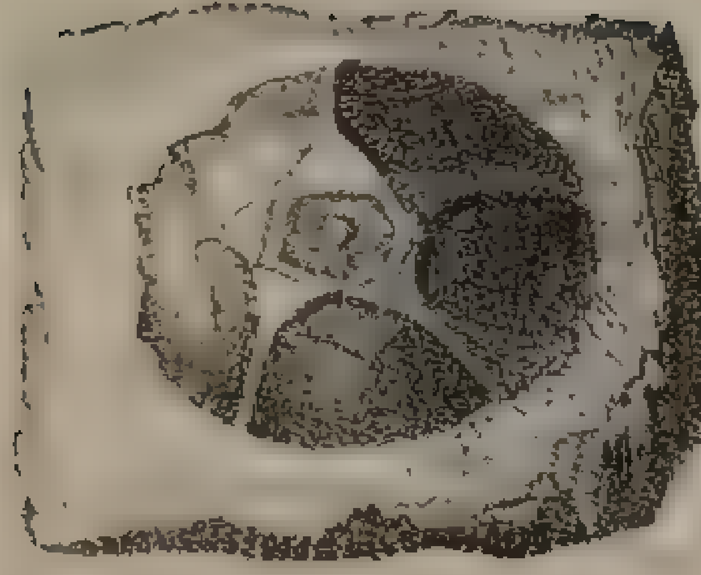

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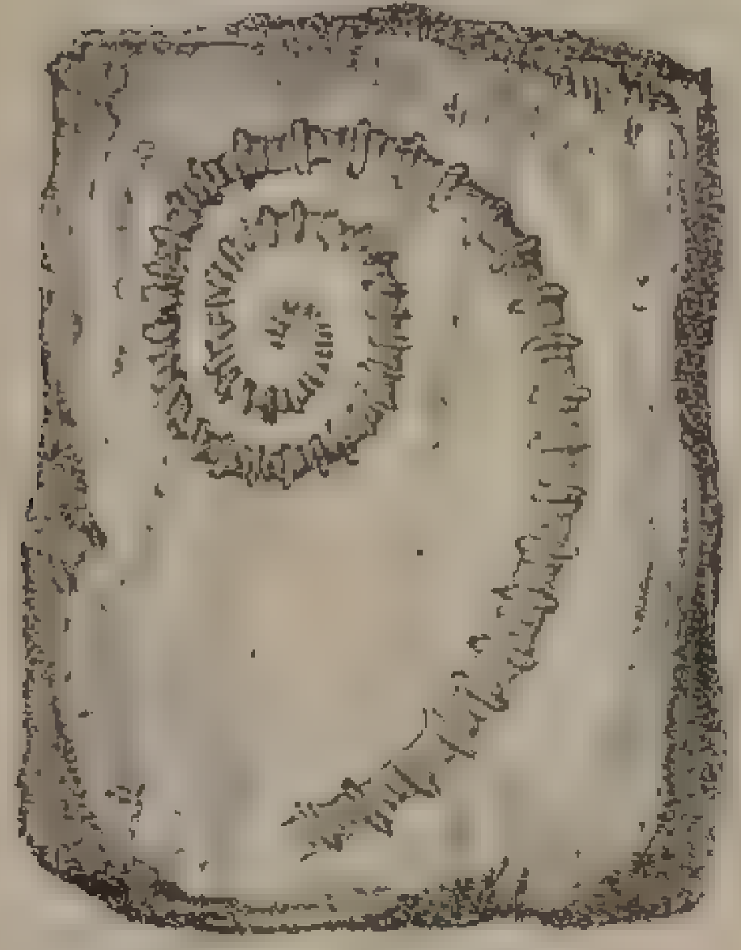

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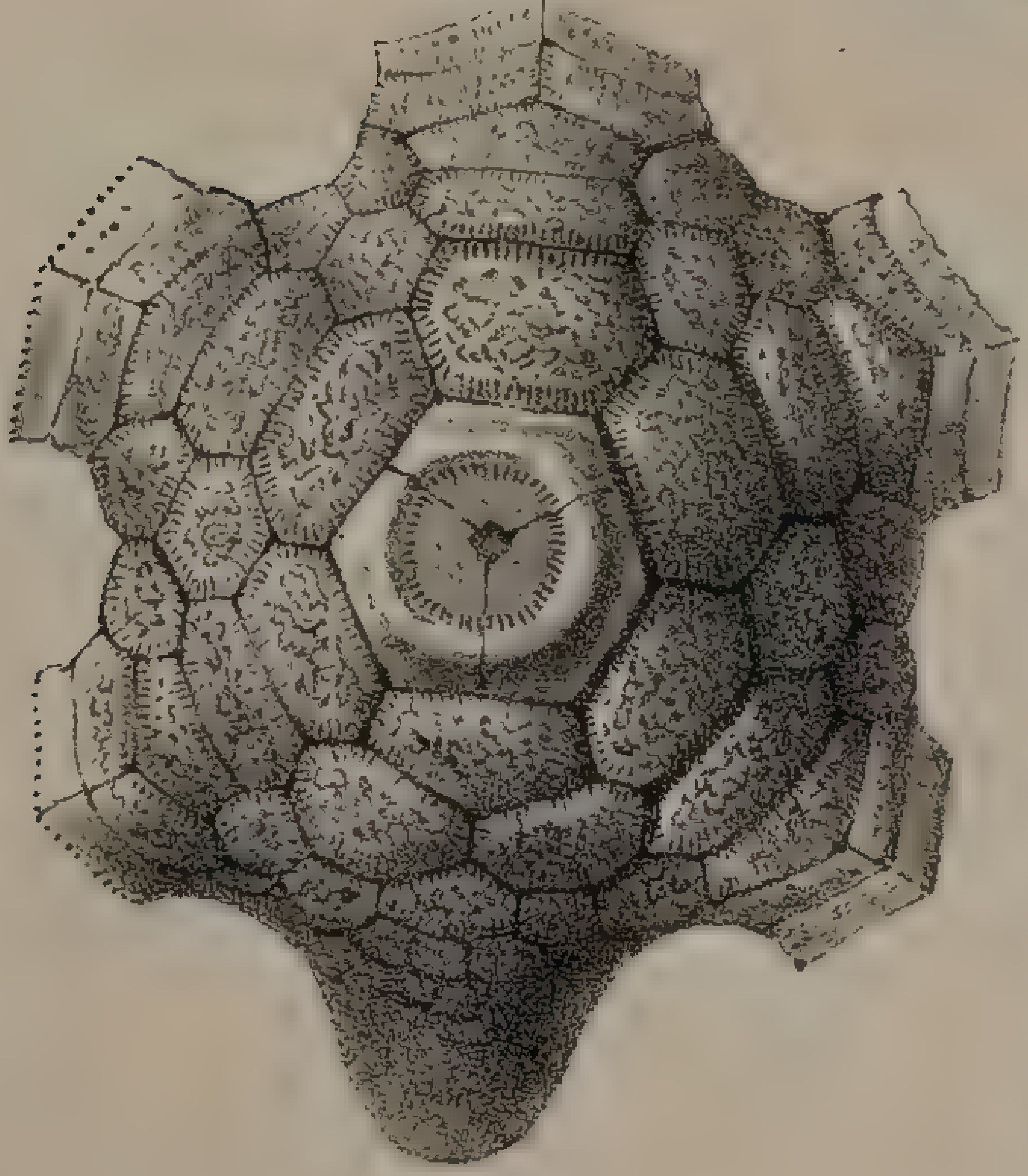

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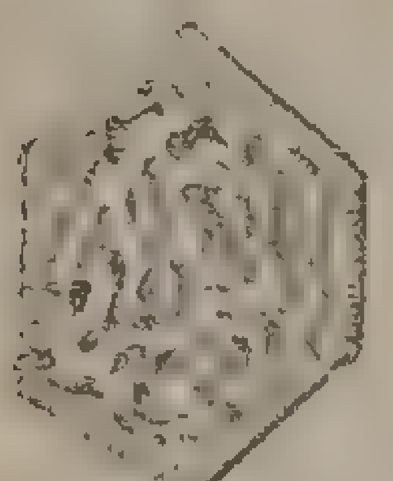

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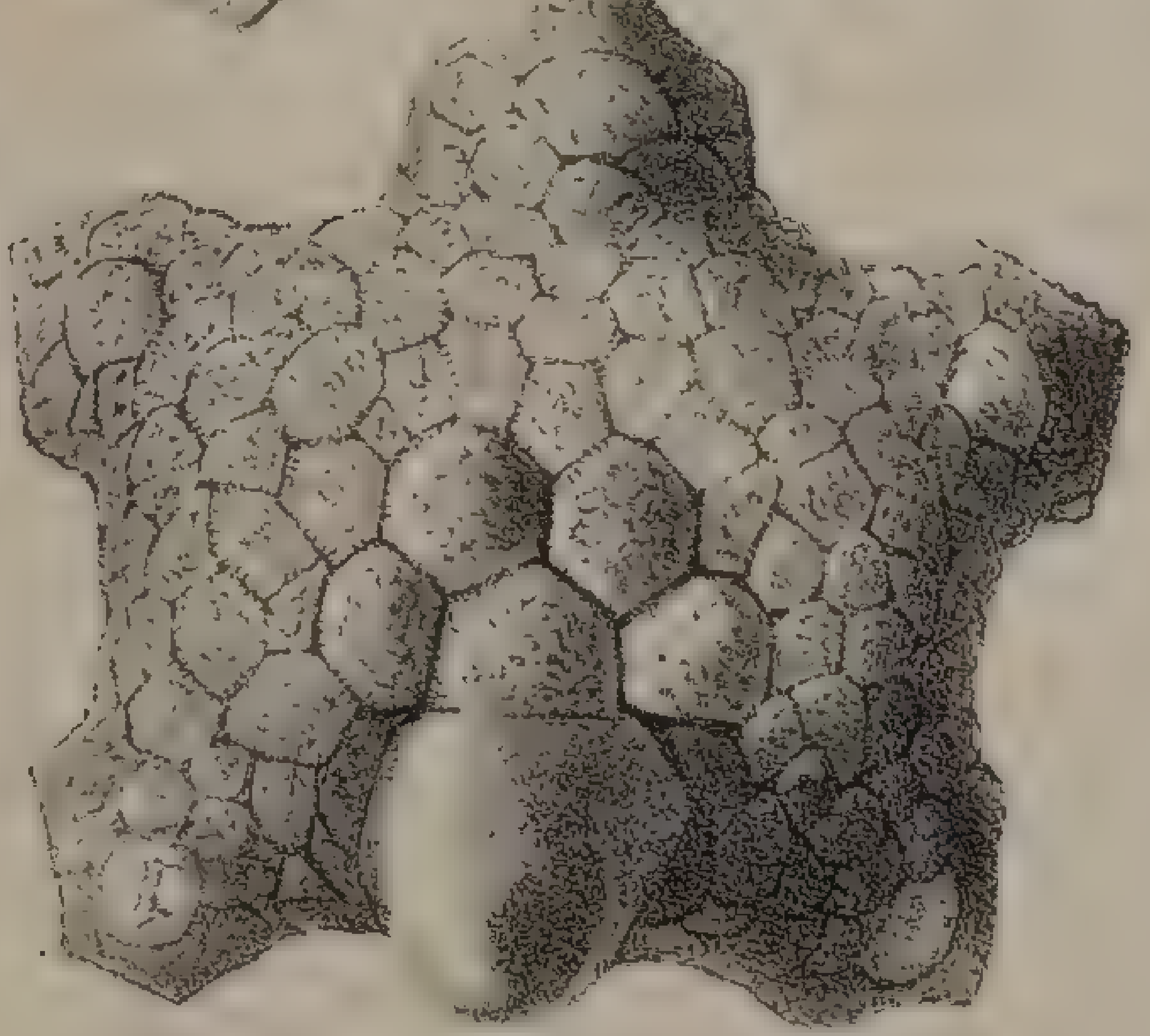

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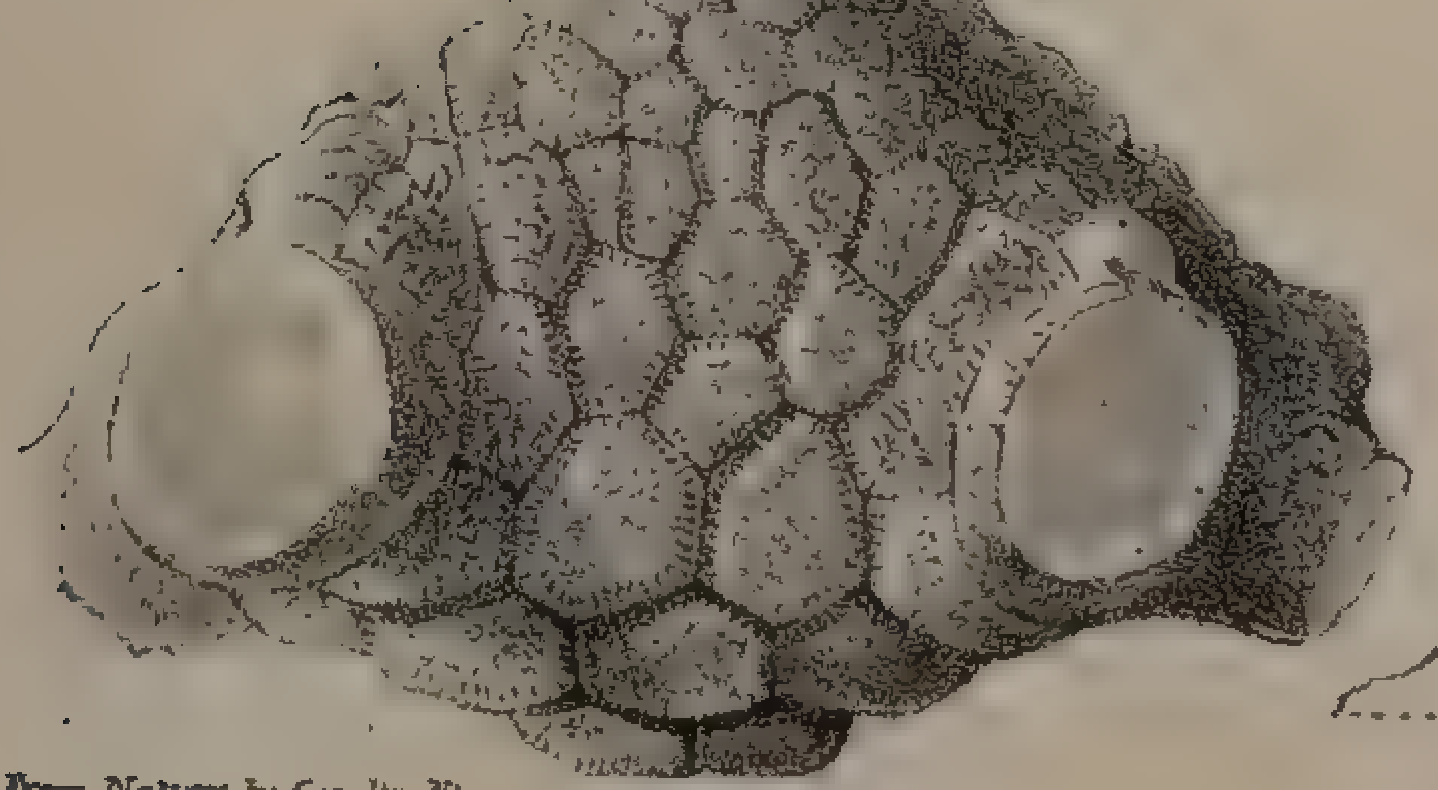

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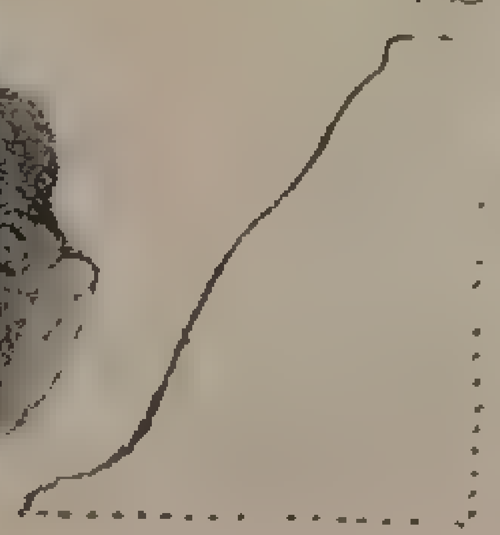

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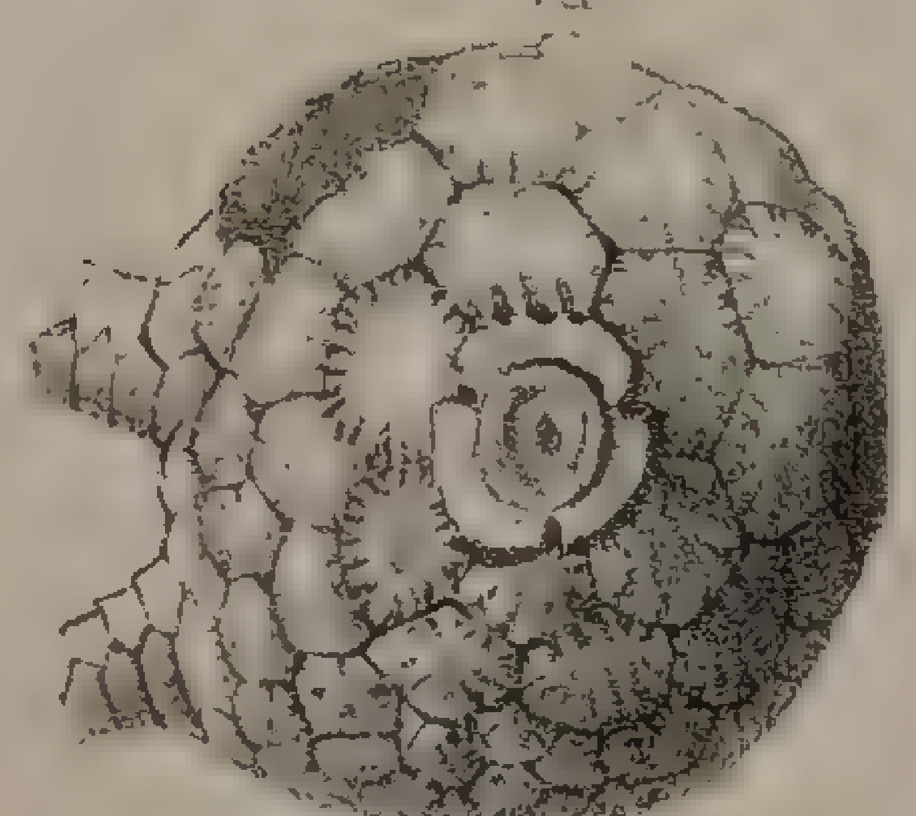

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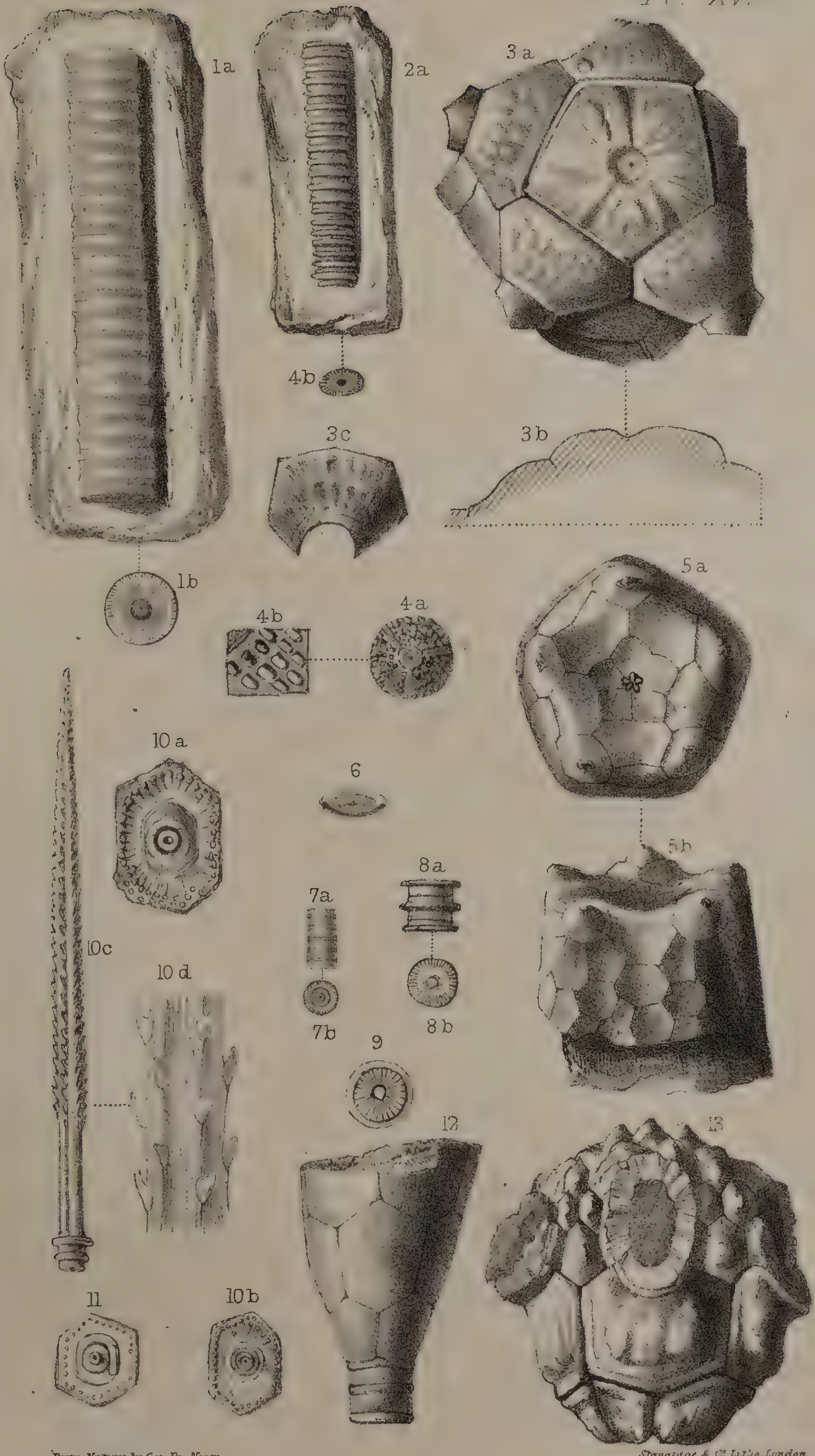
Pl. XV.



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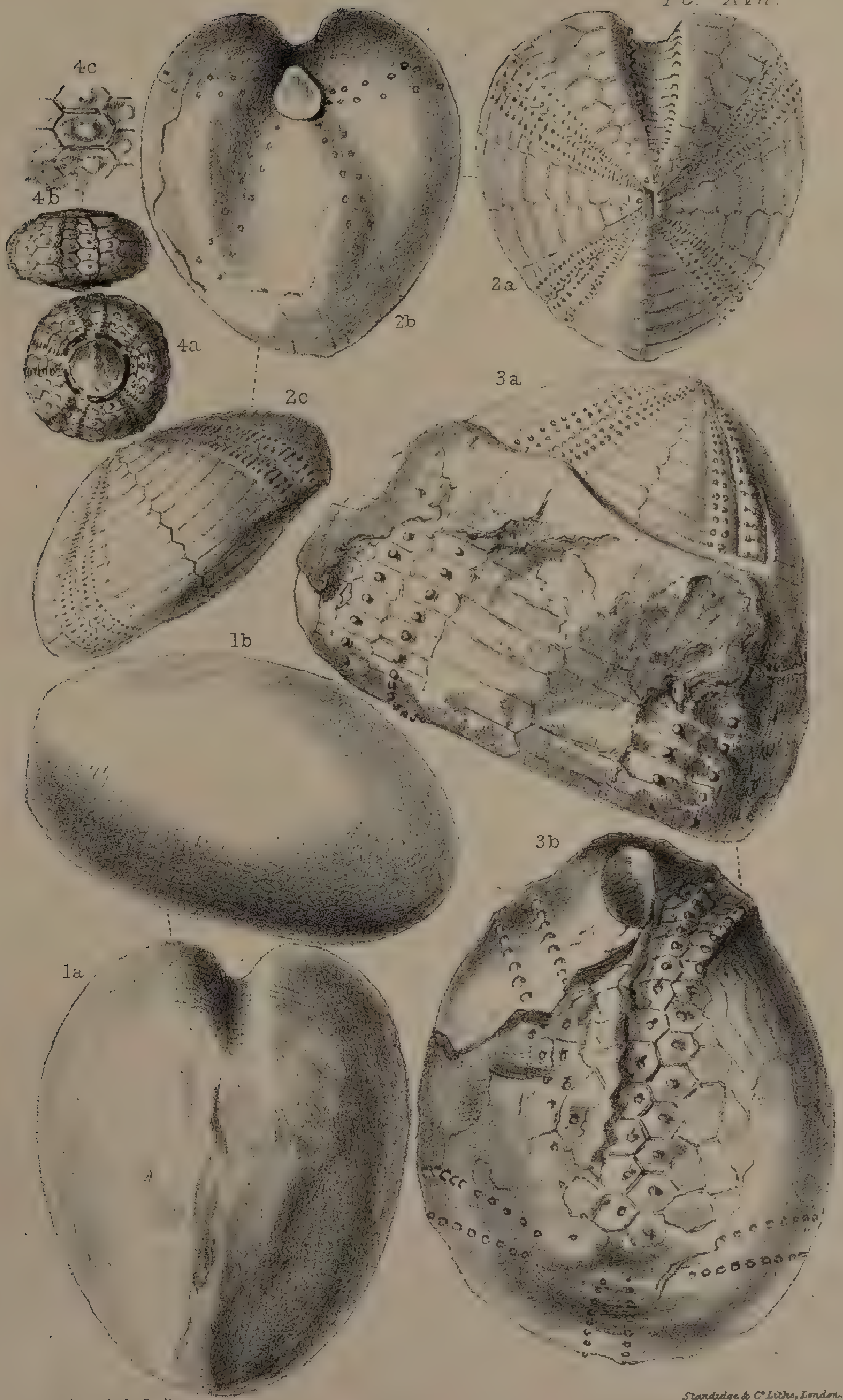
Pl. XVII.



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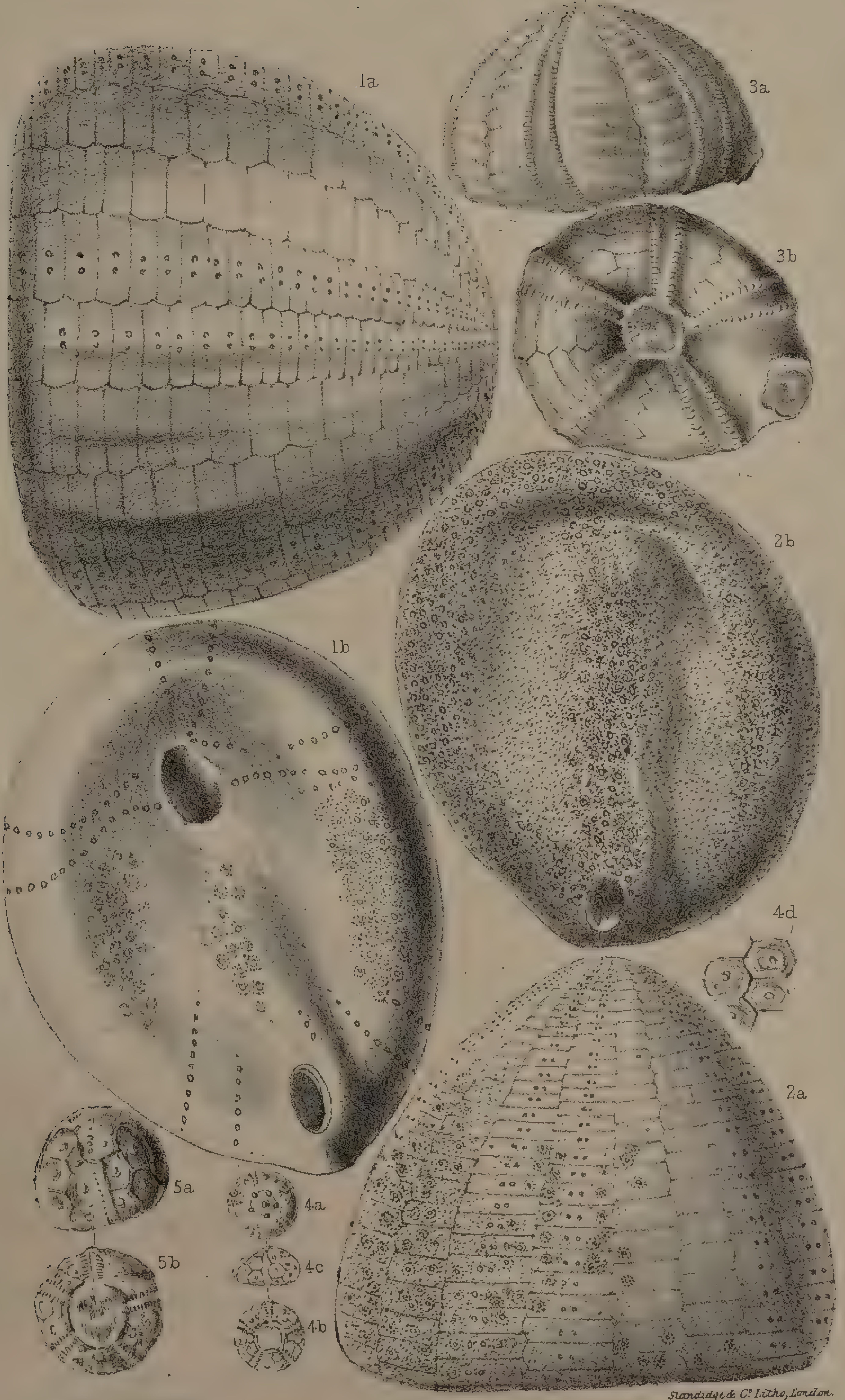
Standidge & Cº Litho, London.

Pl. XVIII.



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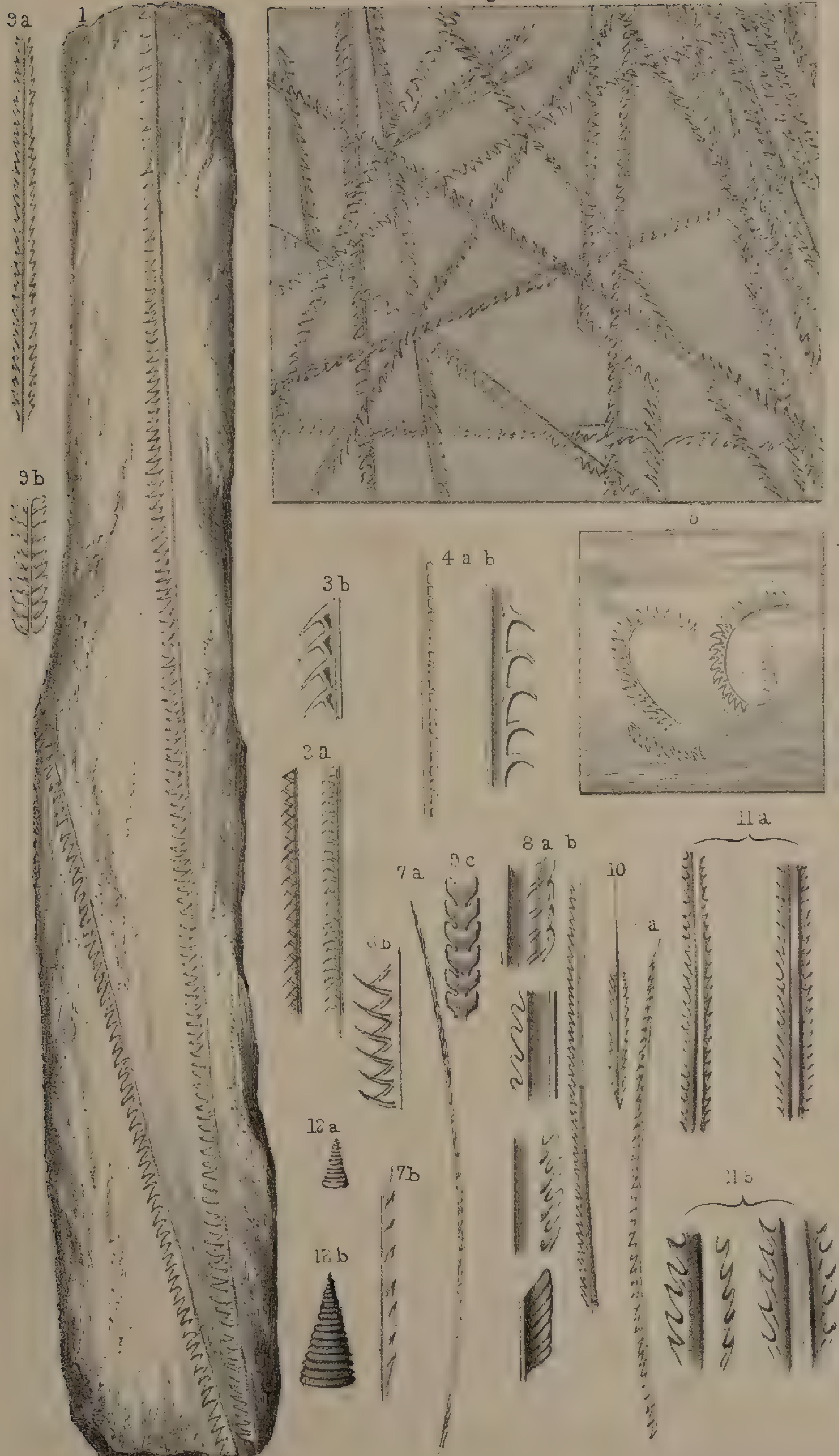
Standidge & C° Litho, London.

Pl. XIX



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Pl. XX

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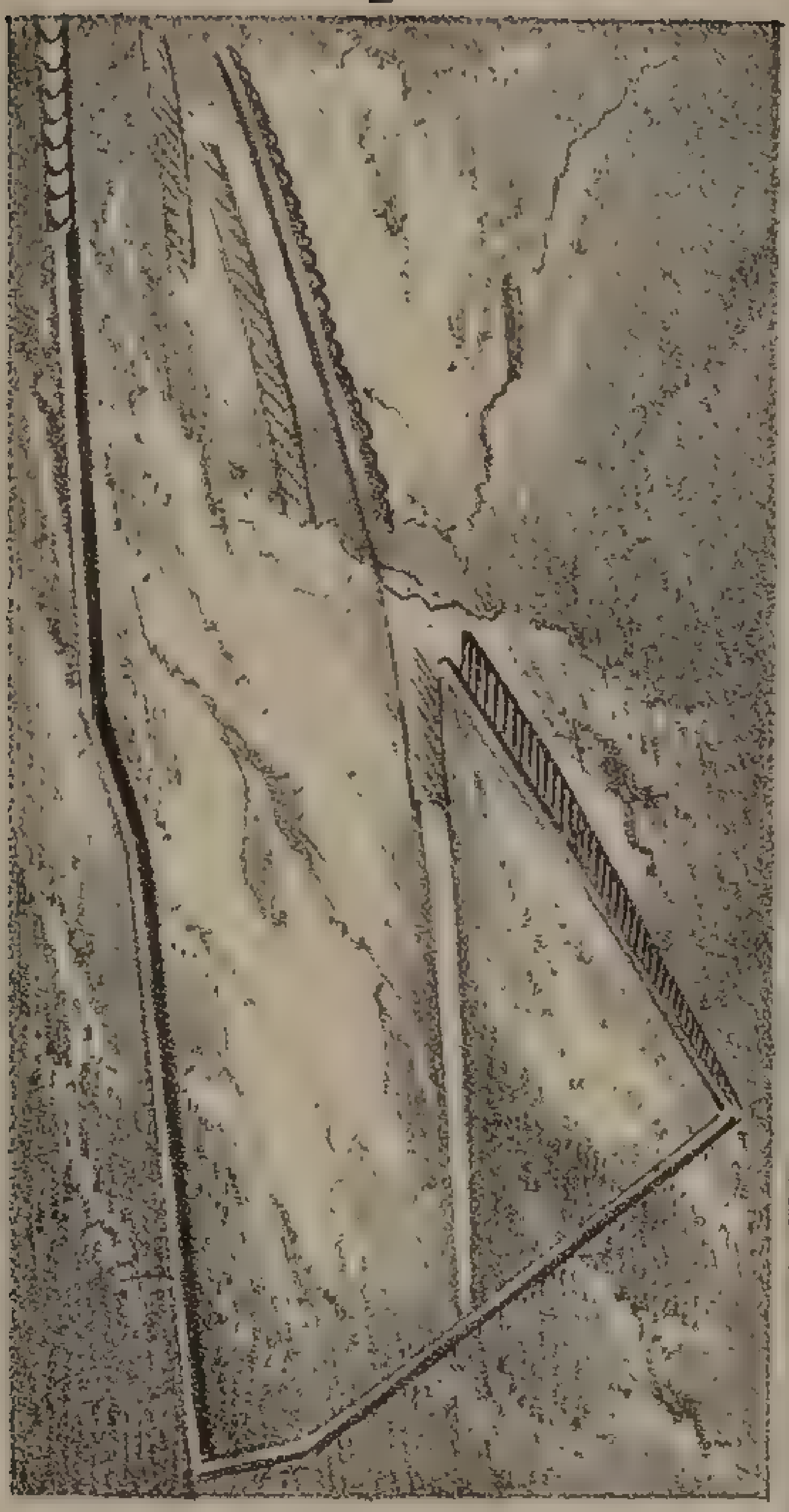

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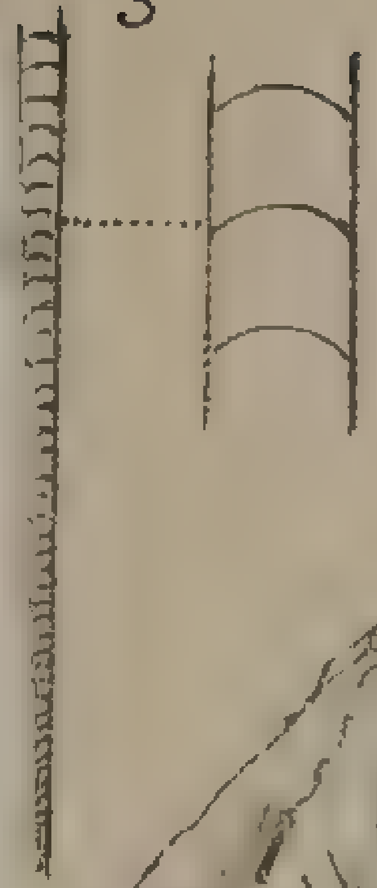

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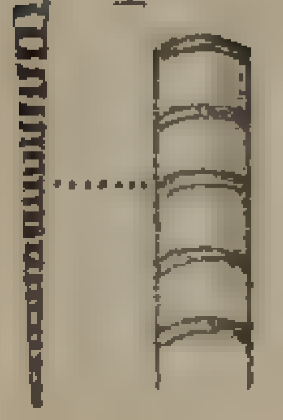

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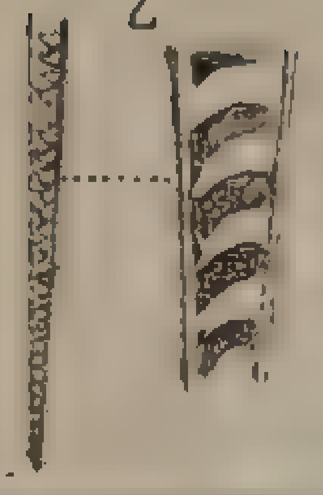

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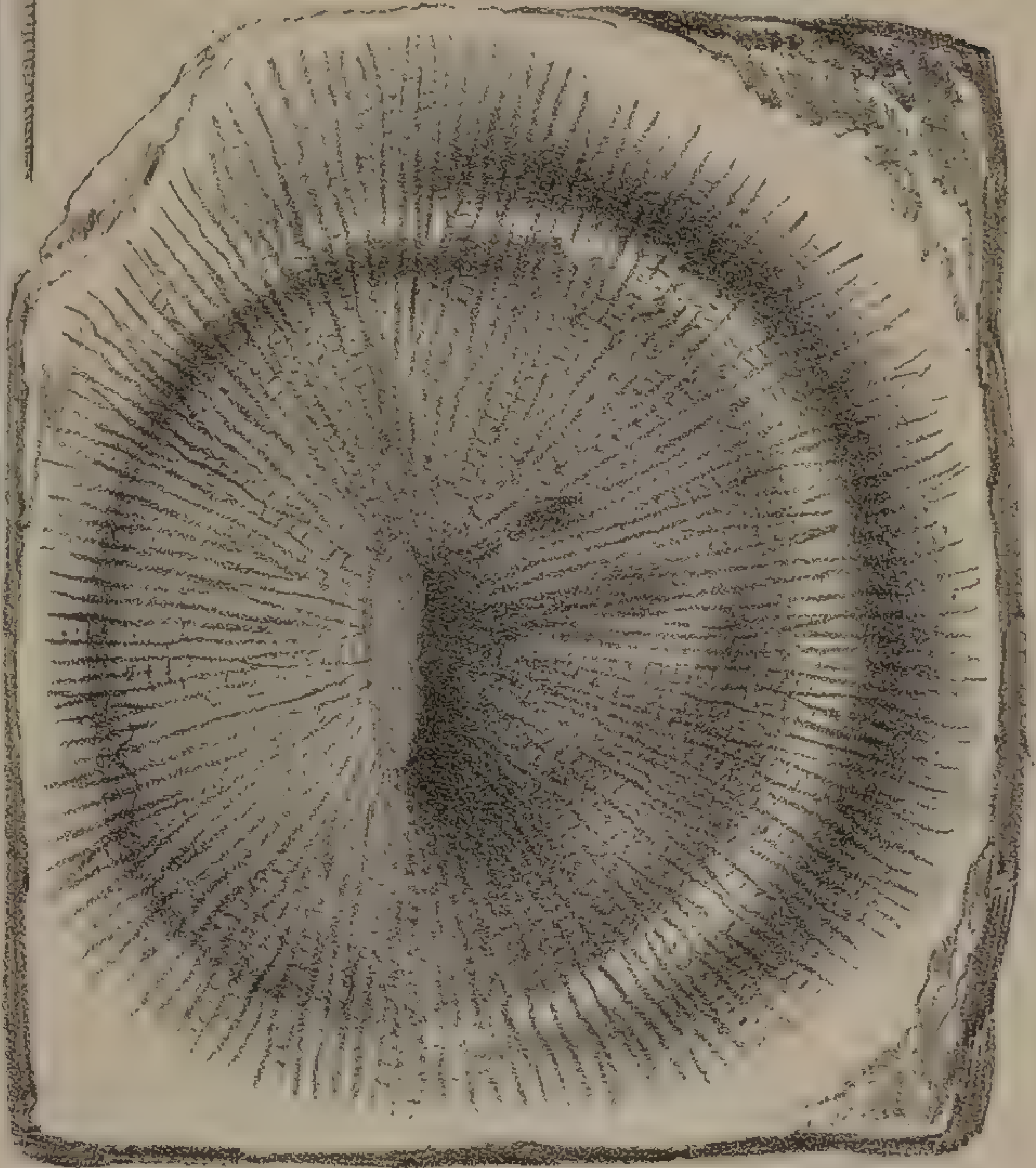

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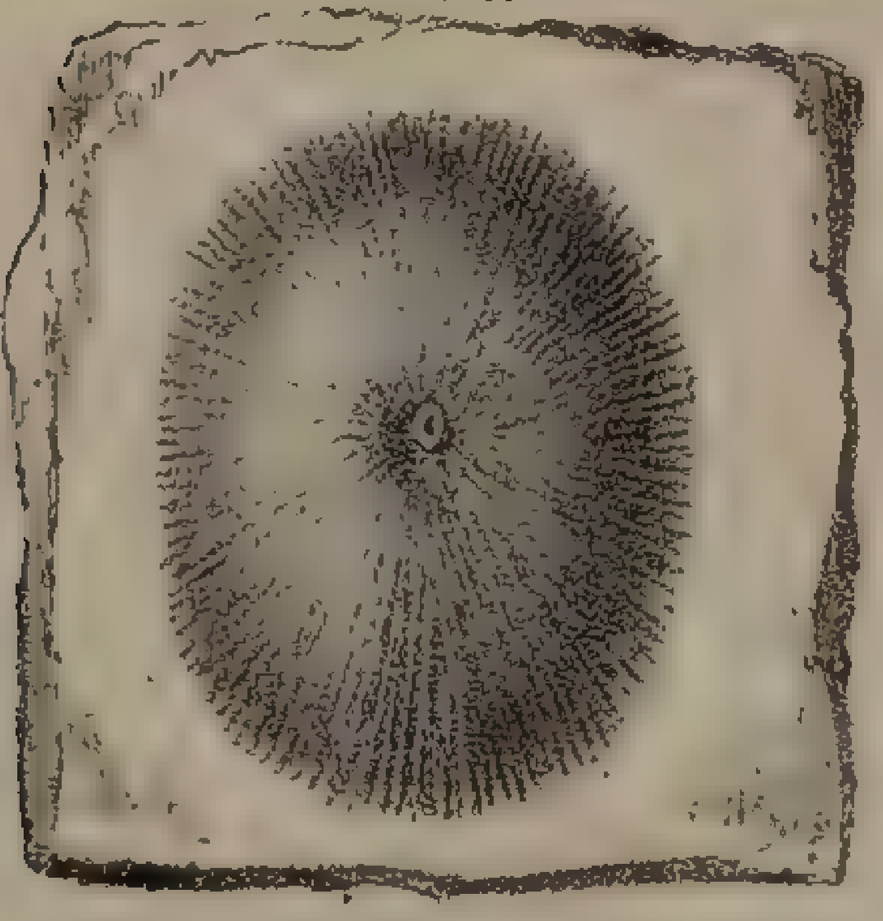

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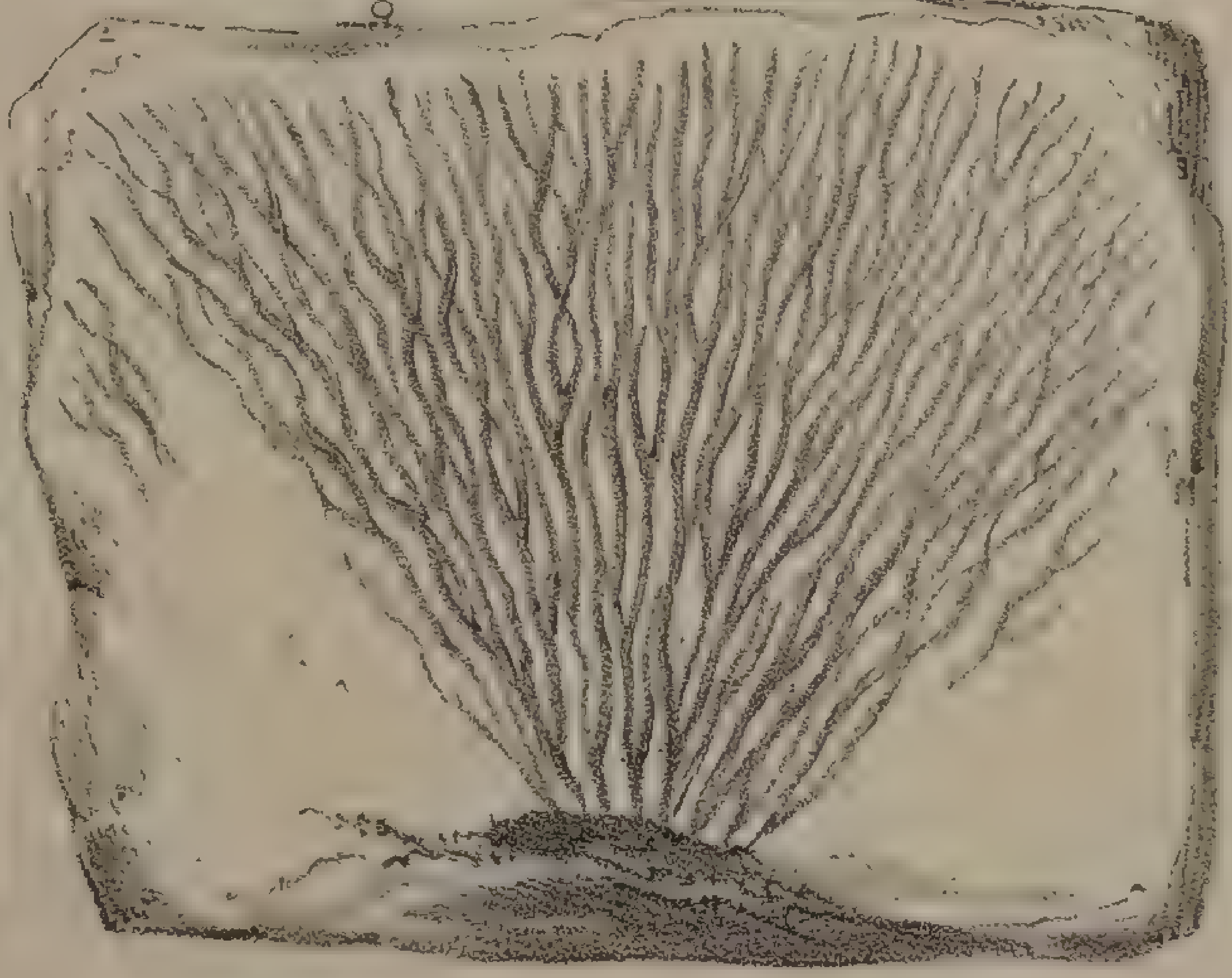

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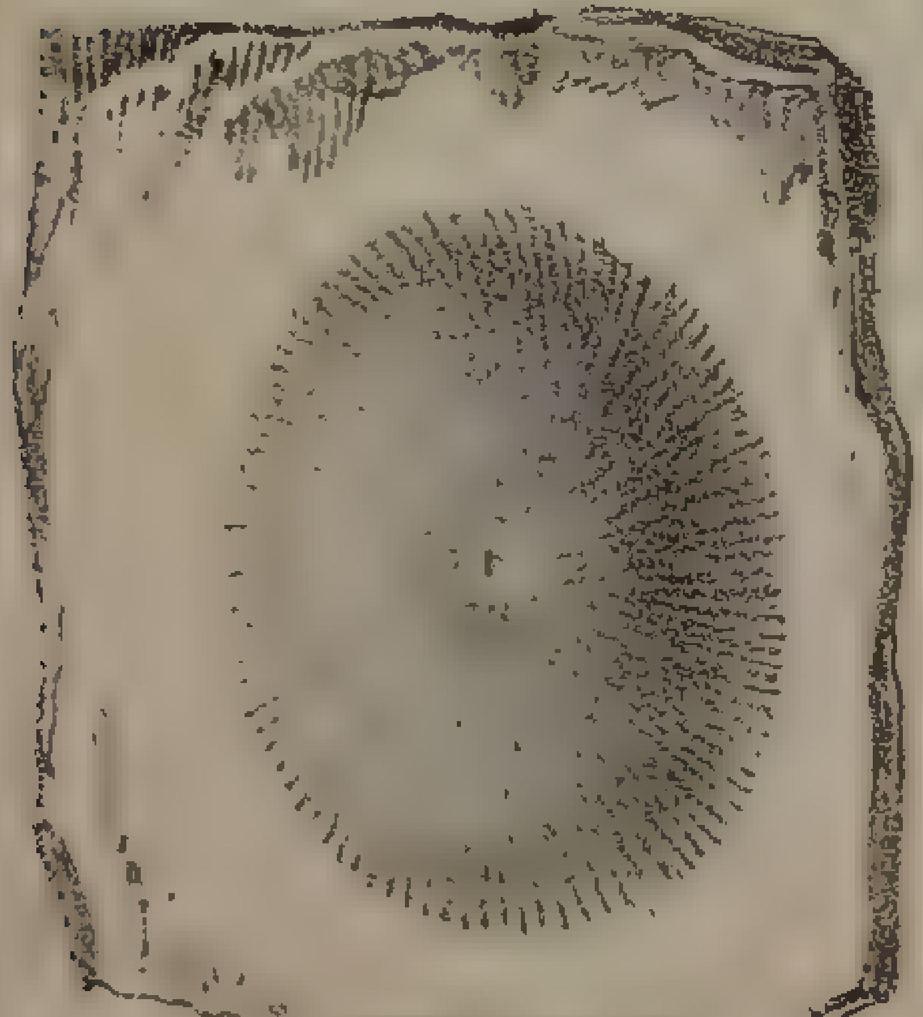

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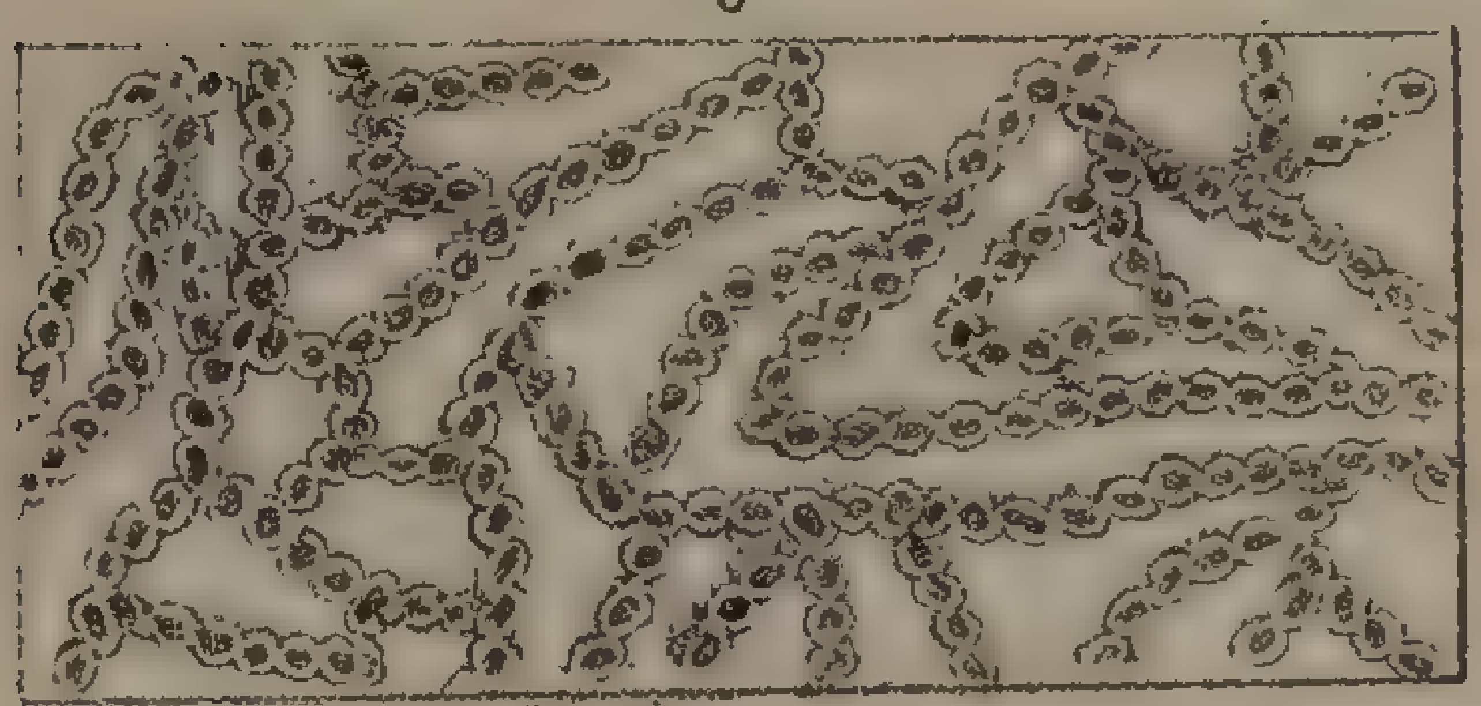

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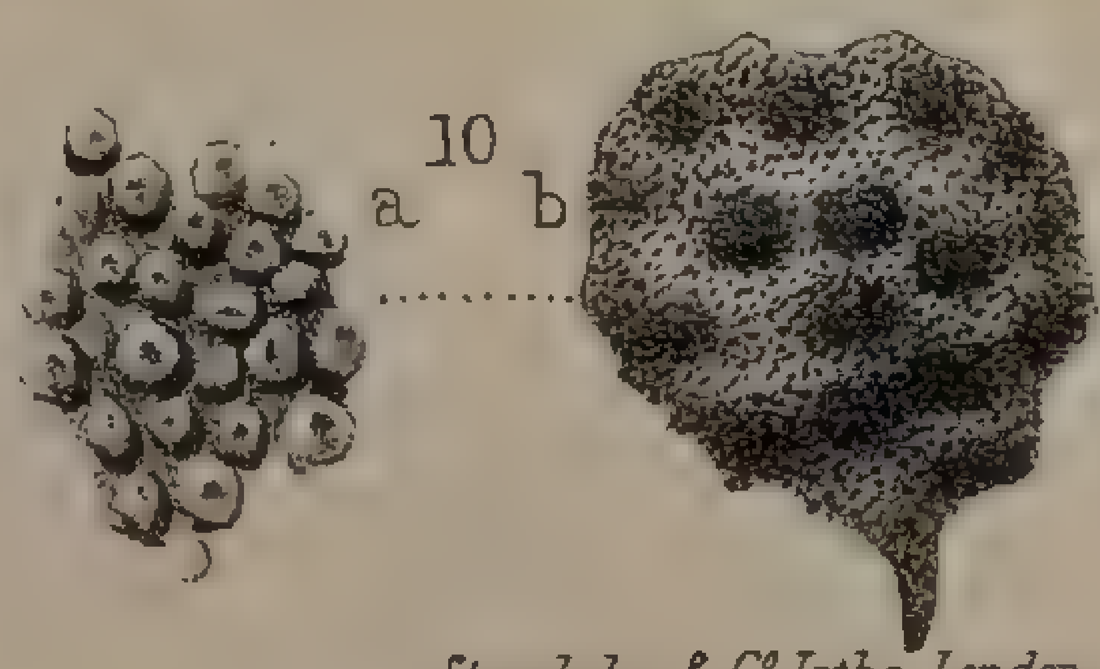

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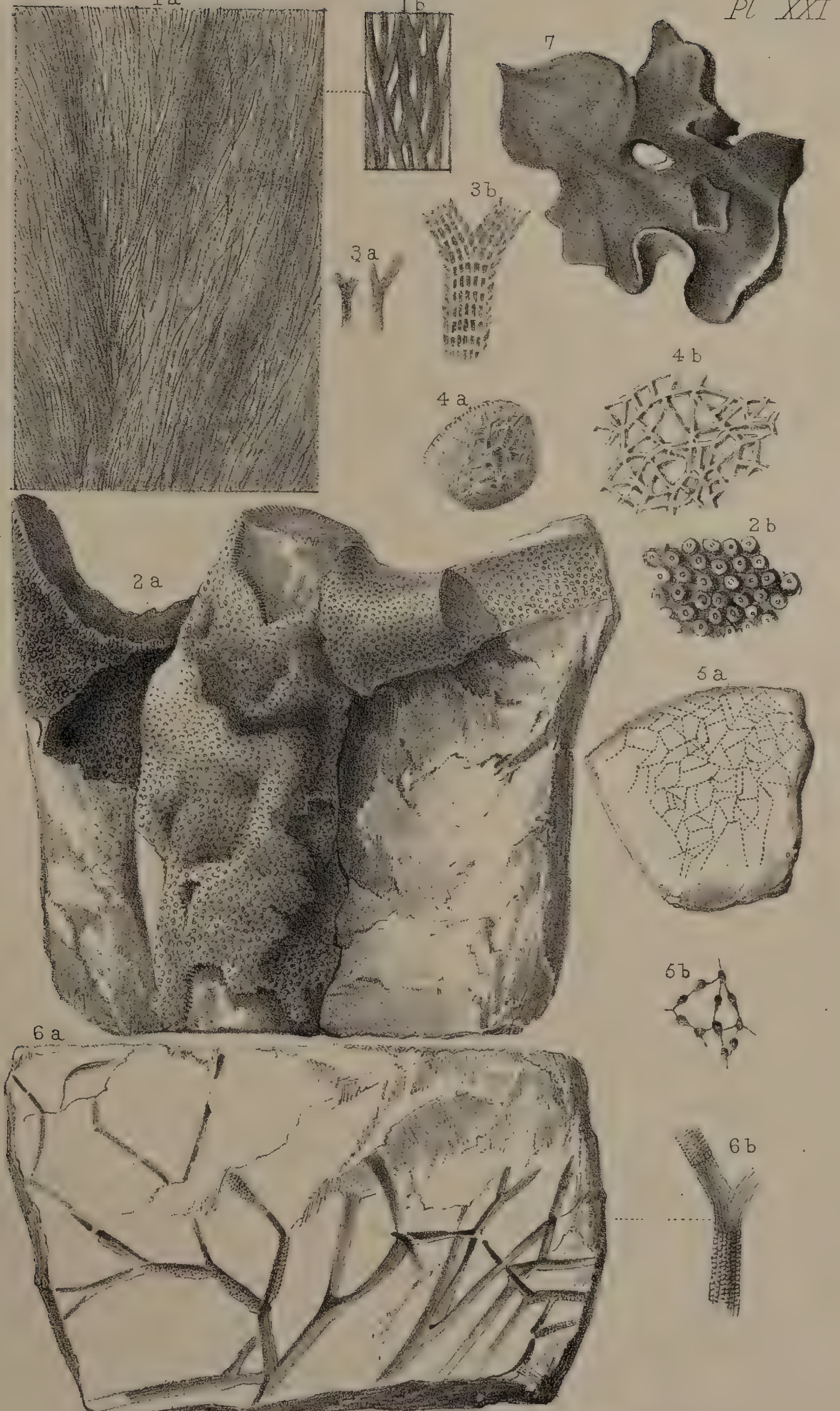
Pl XXI



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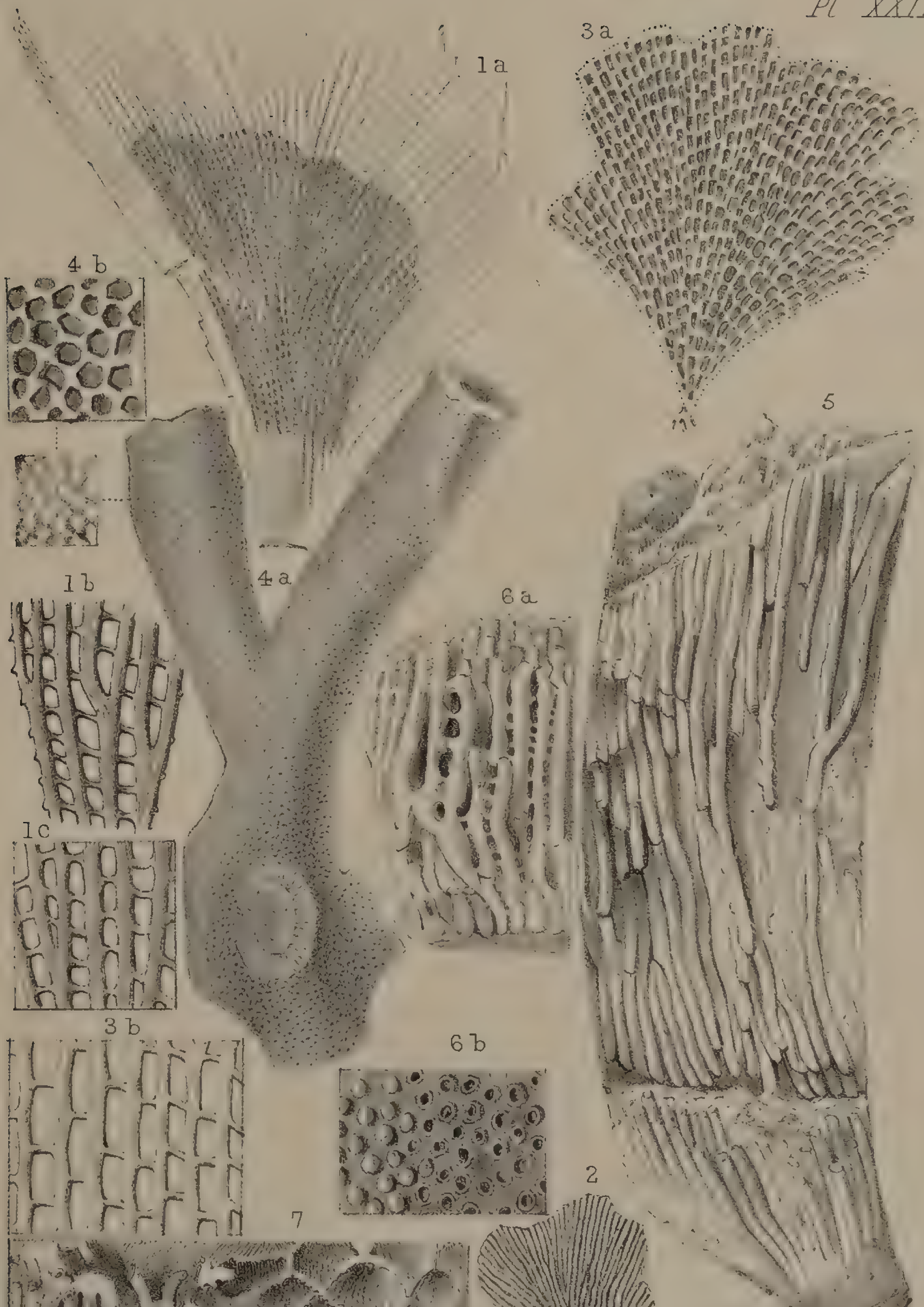
Pl XXII



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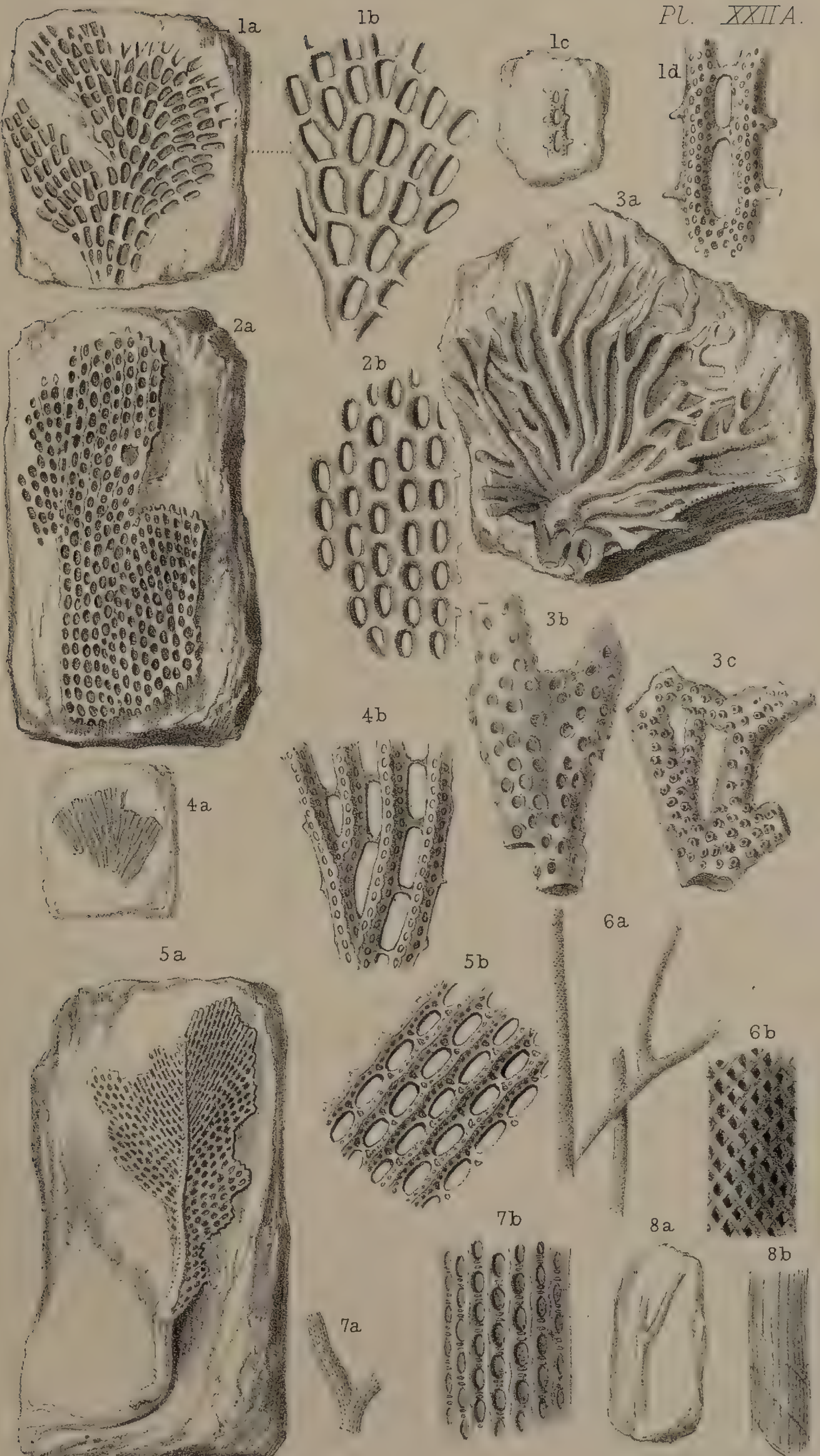
Pl. XXII A.



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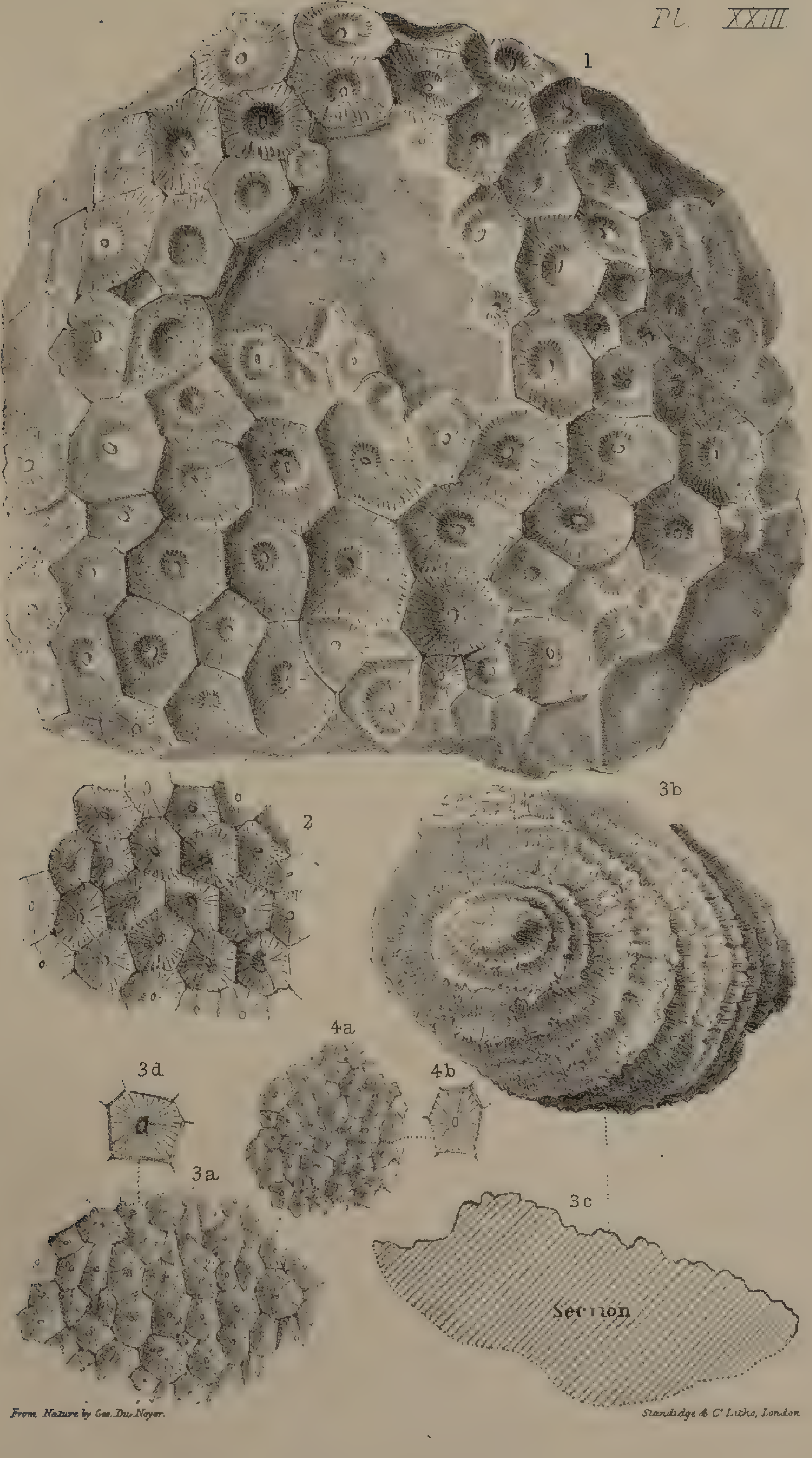
Pl. XXIII



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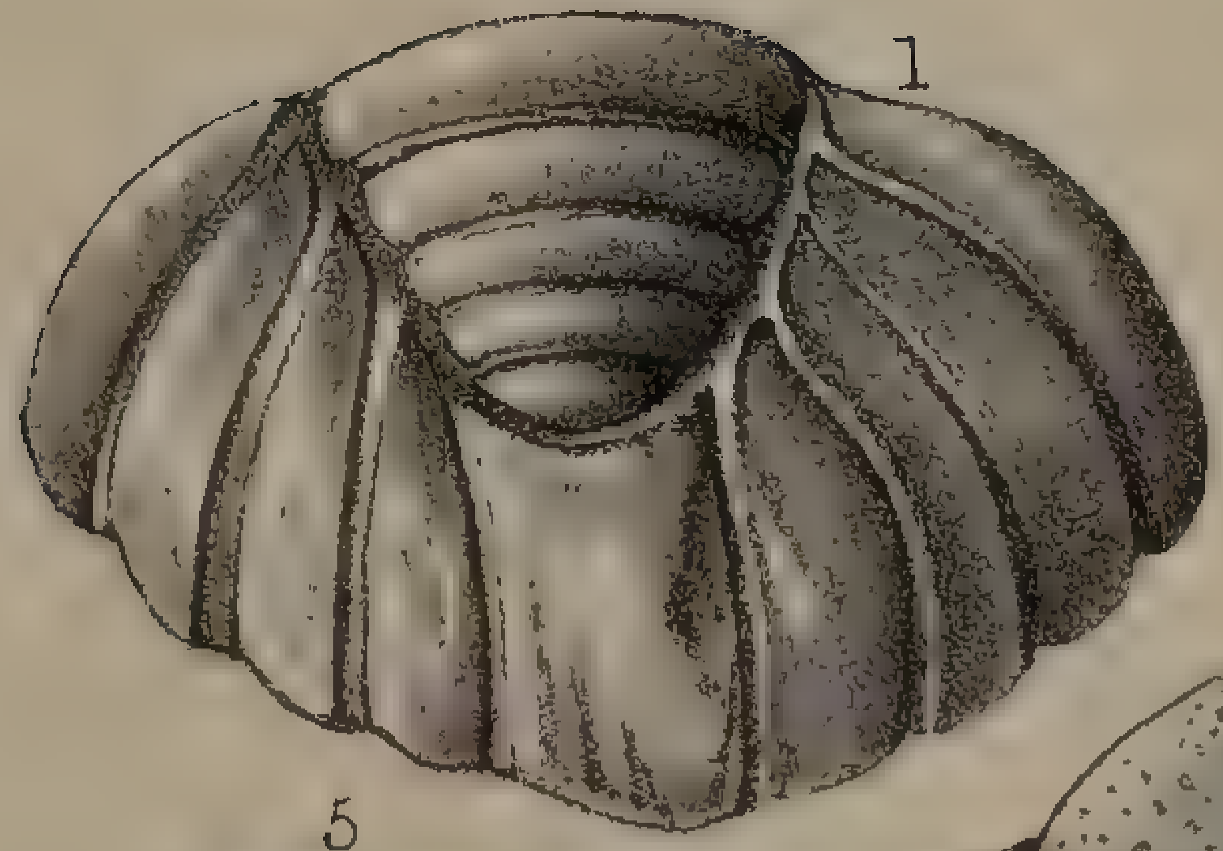
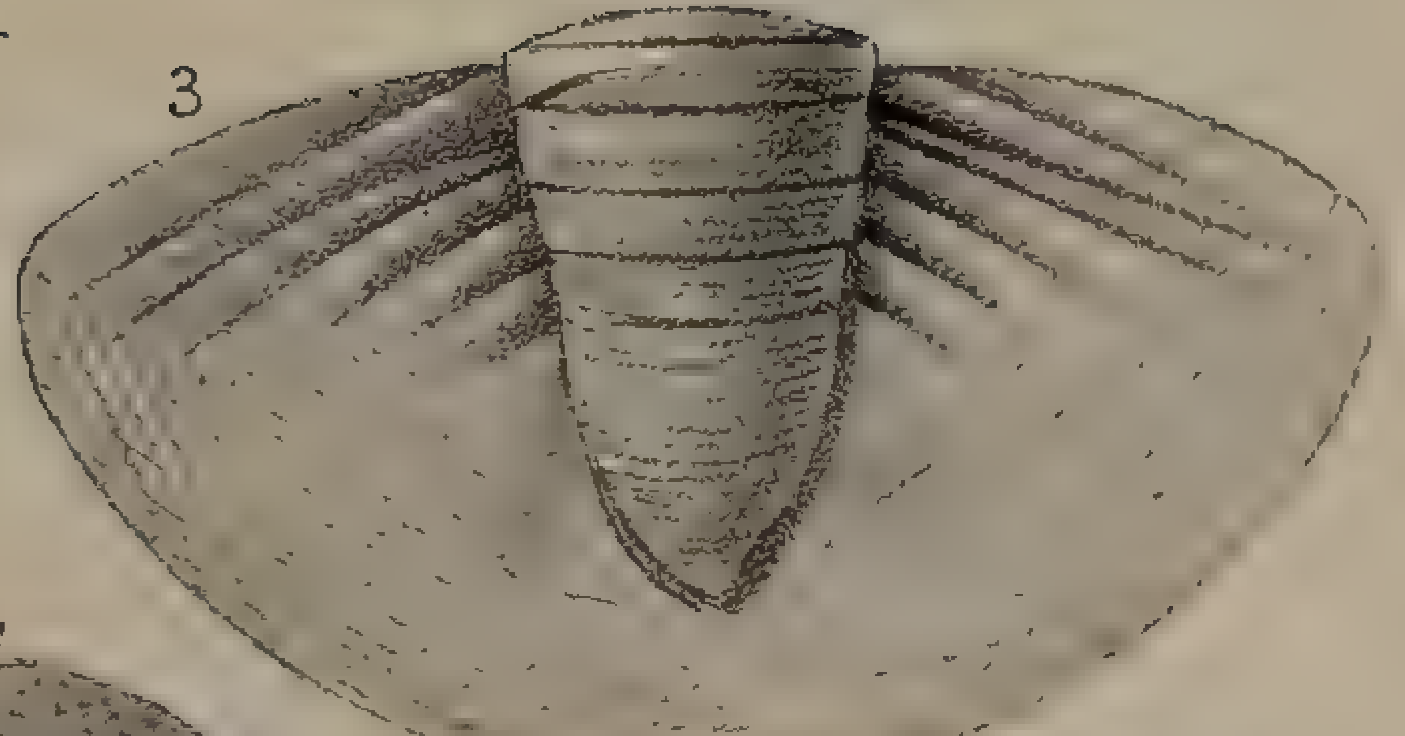
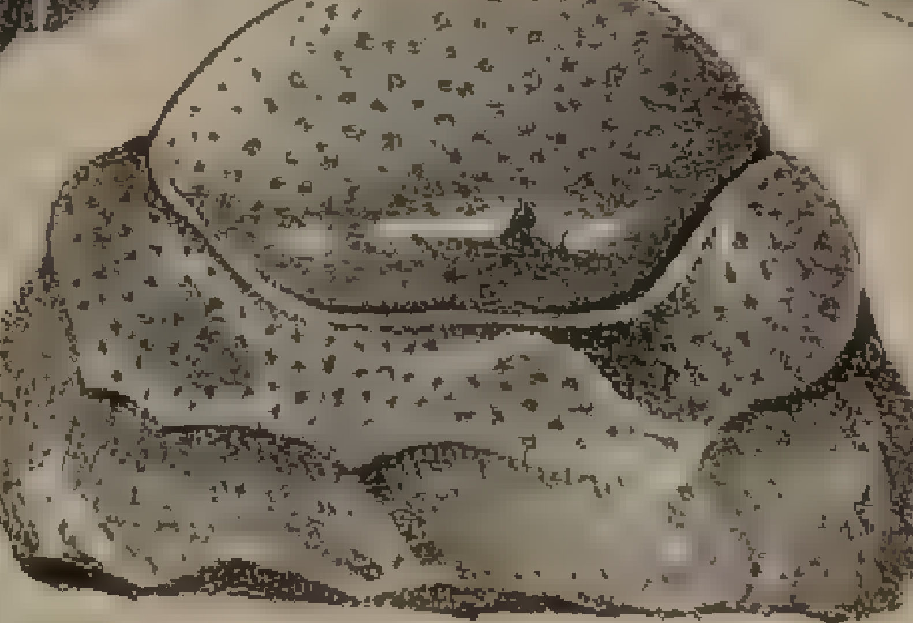
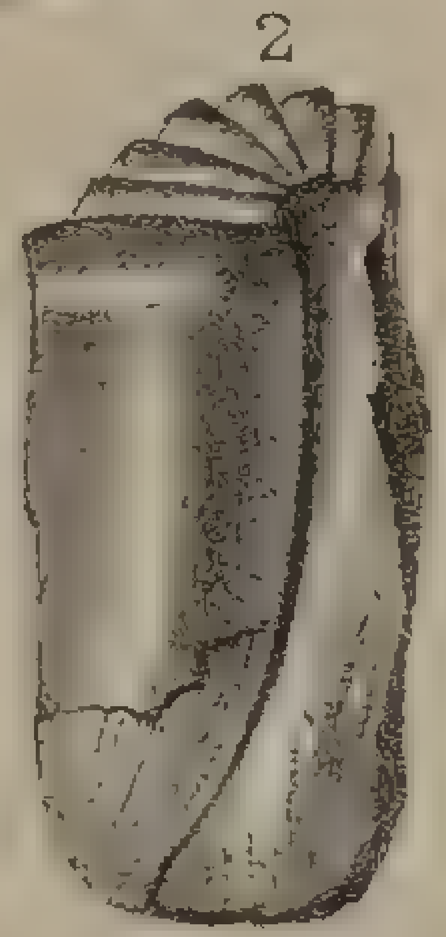
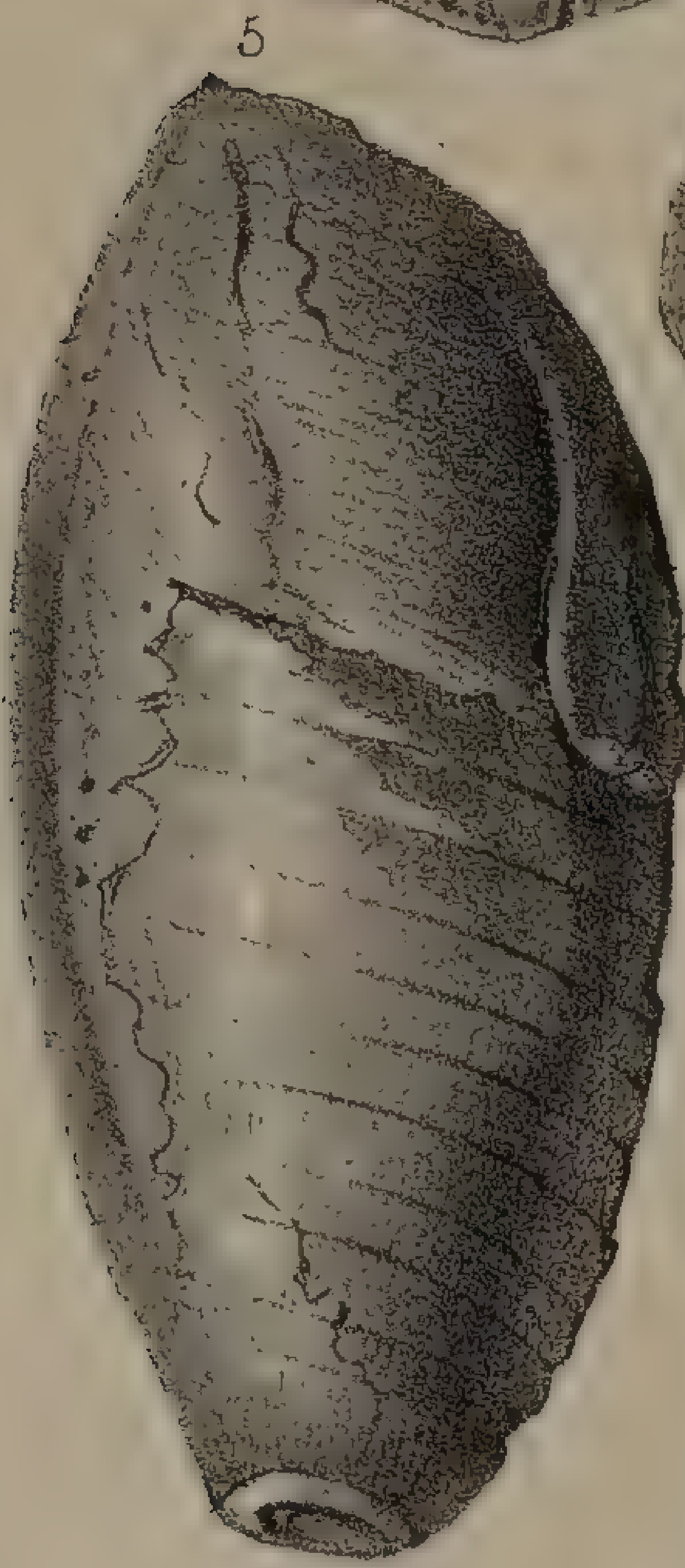
Pl. XXIV

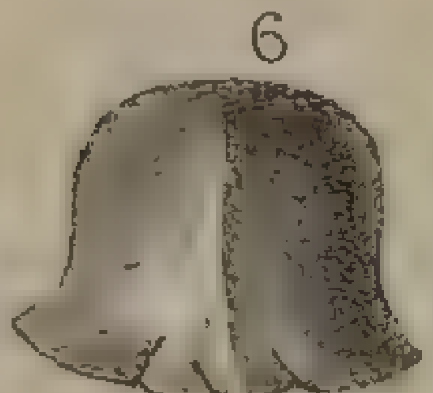


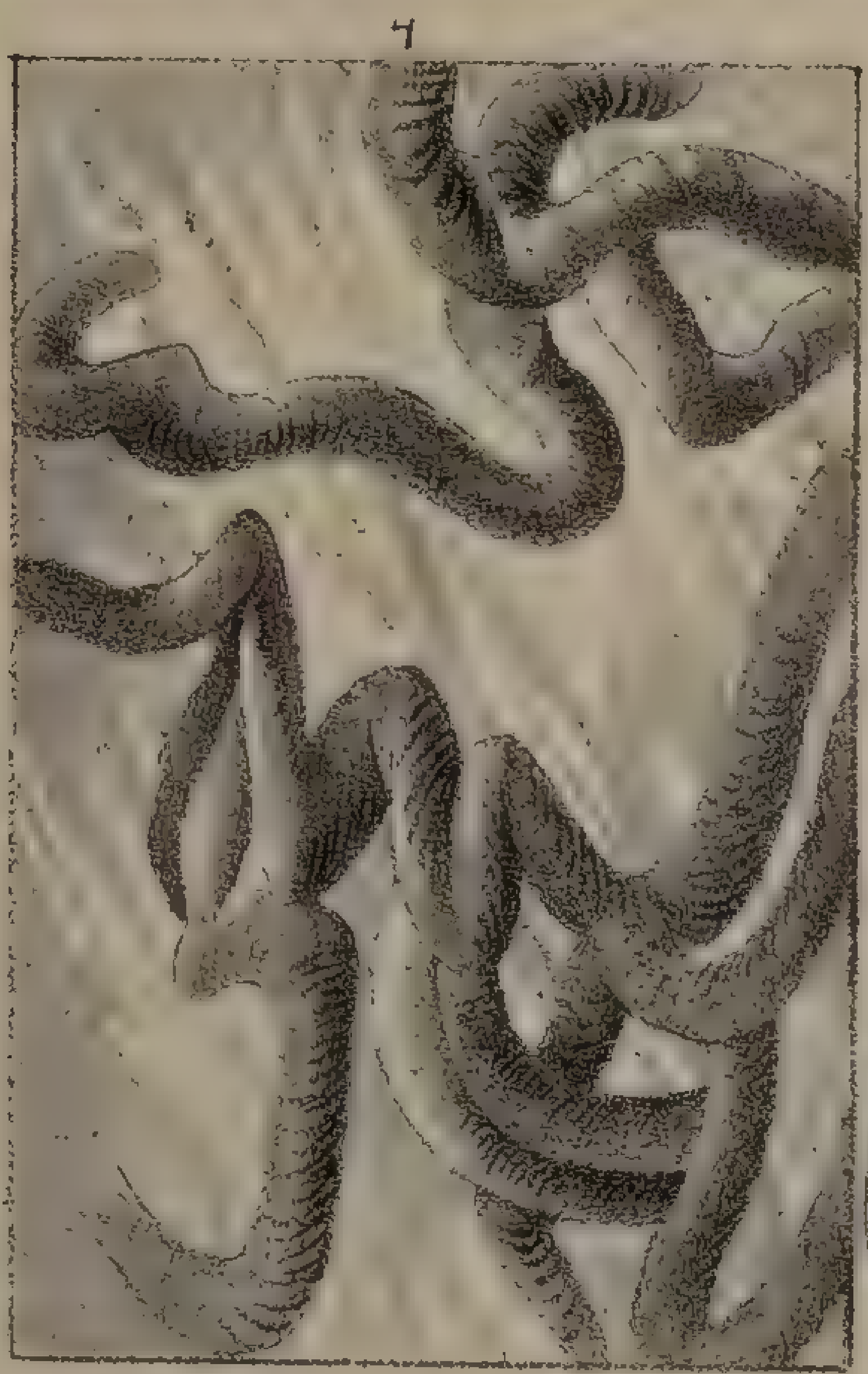


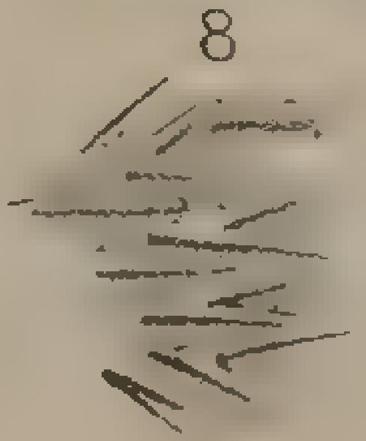


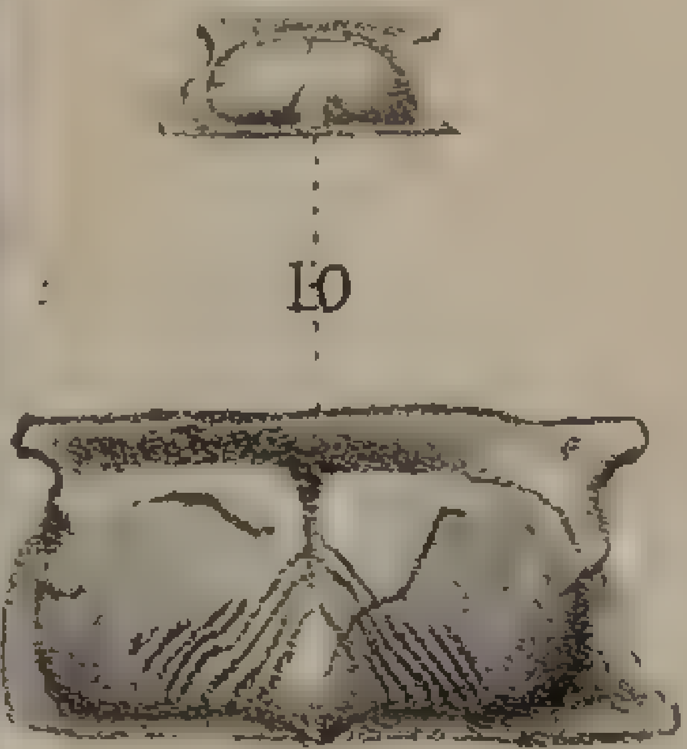


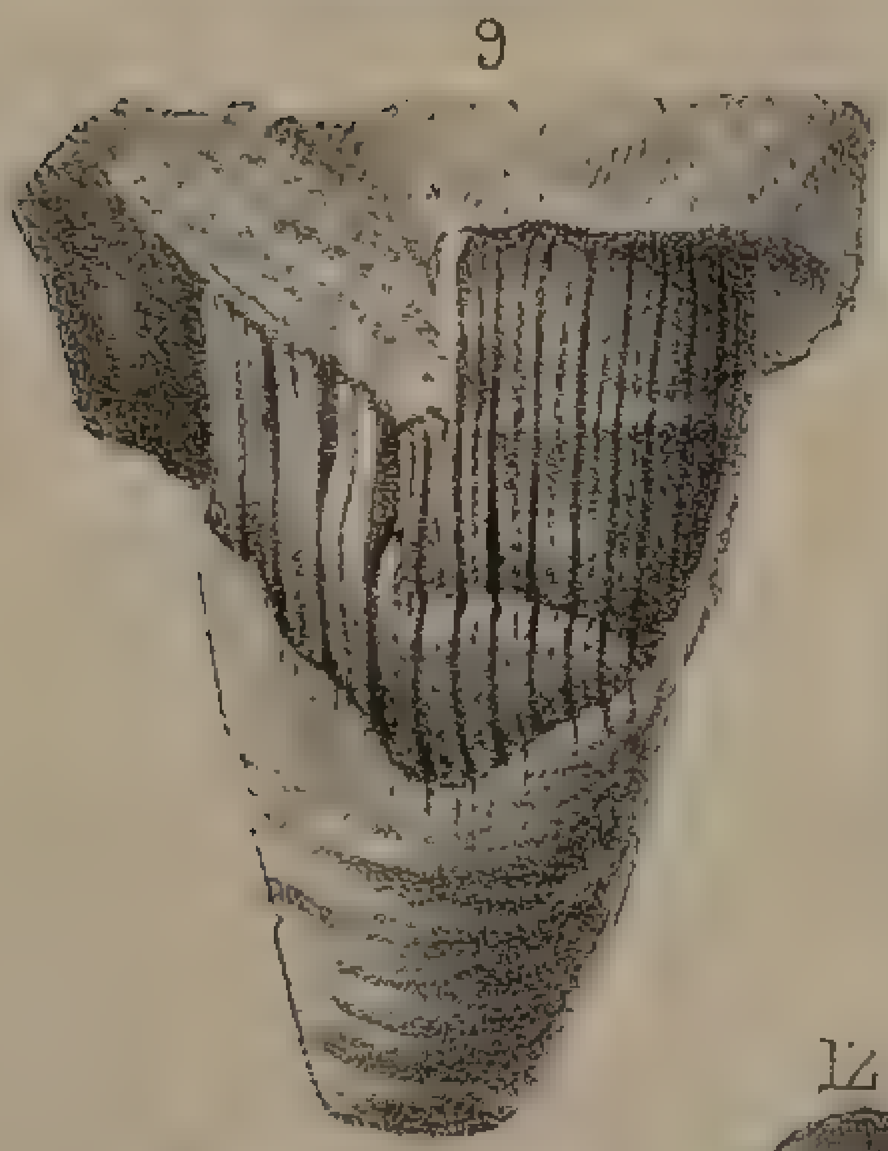


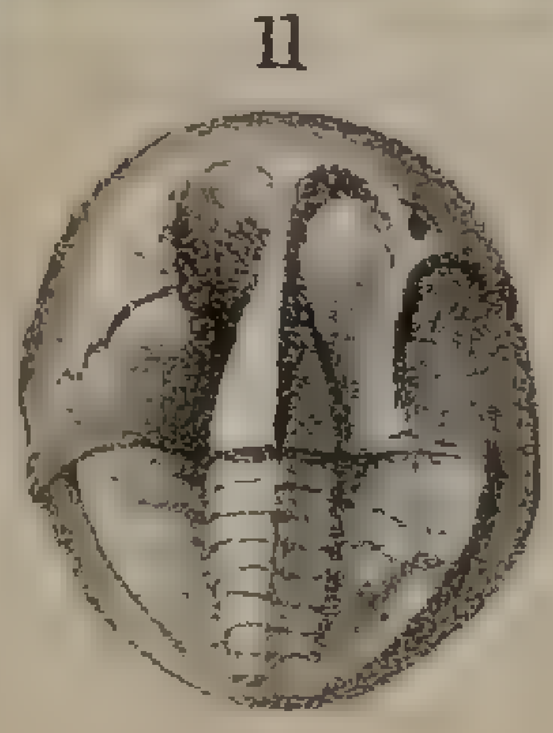


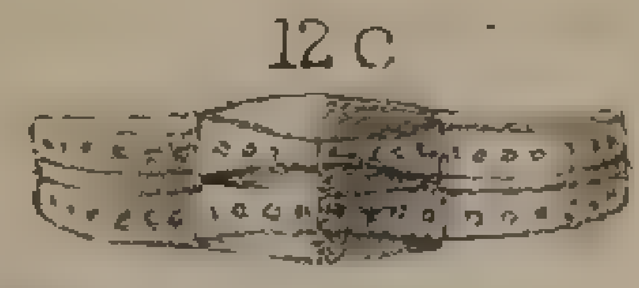


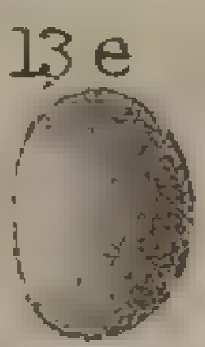


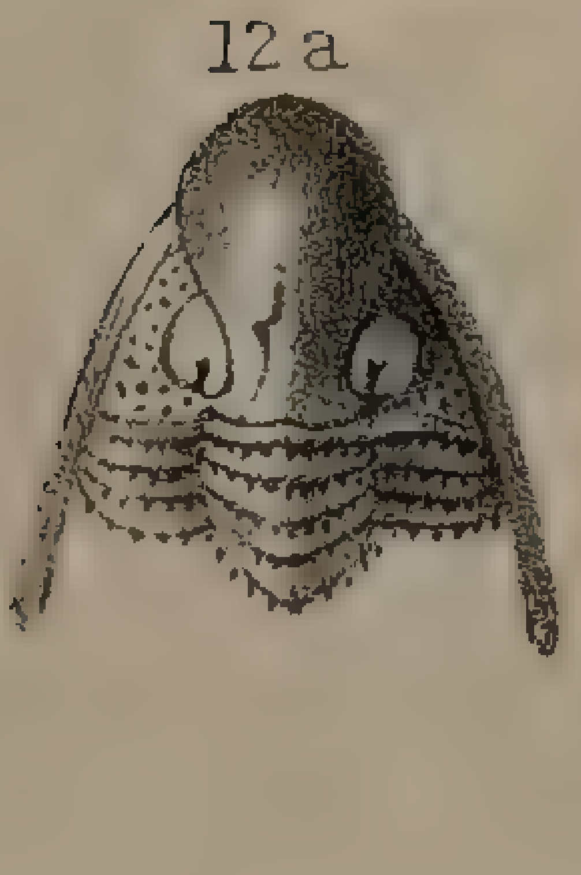


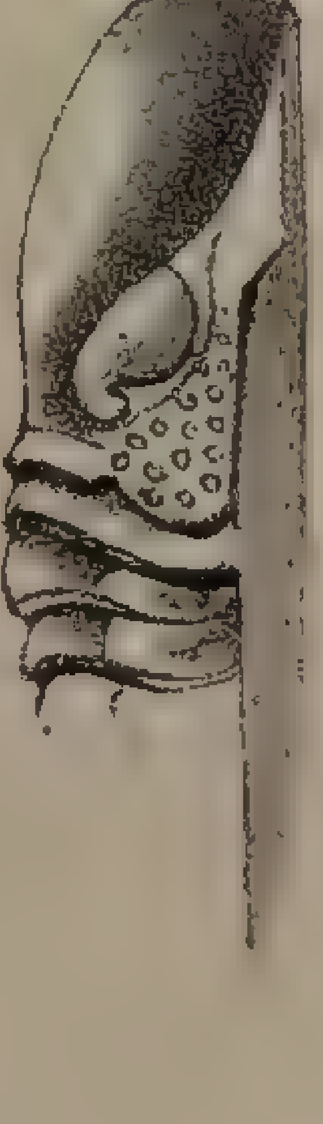


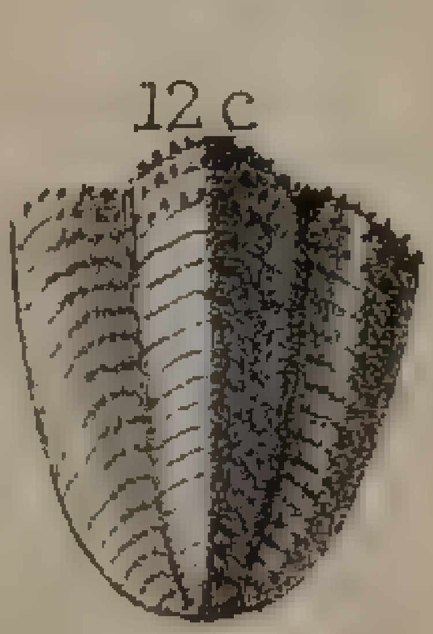


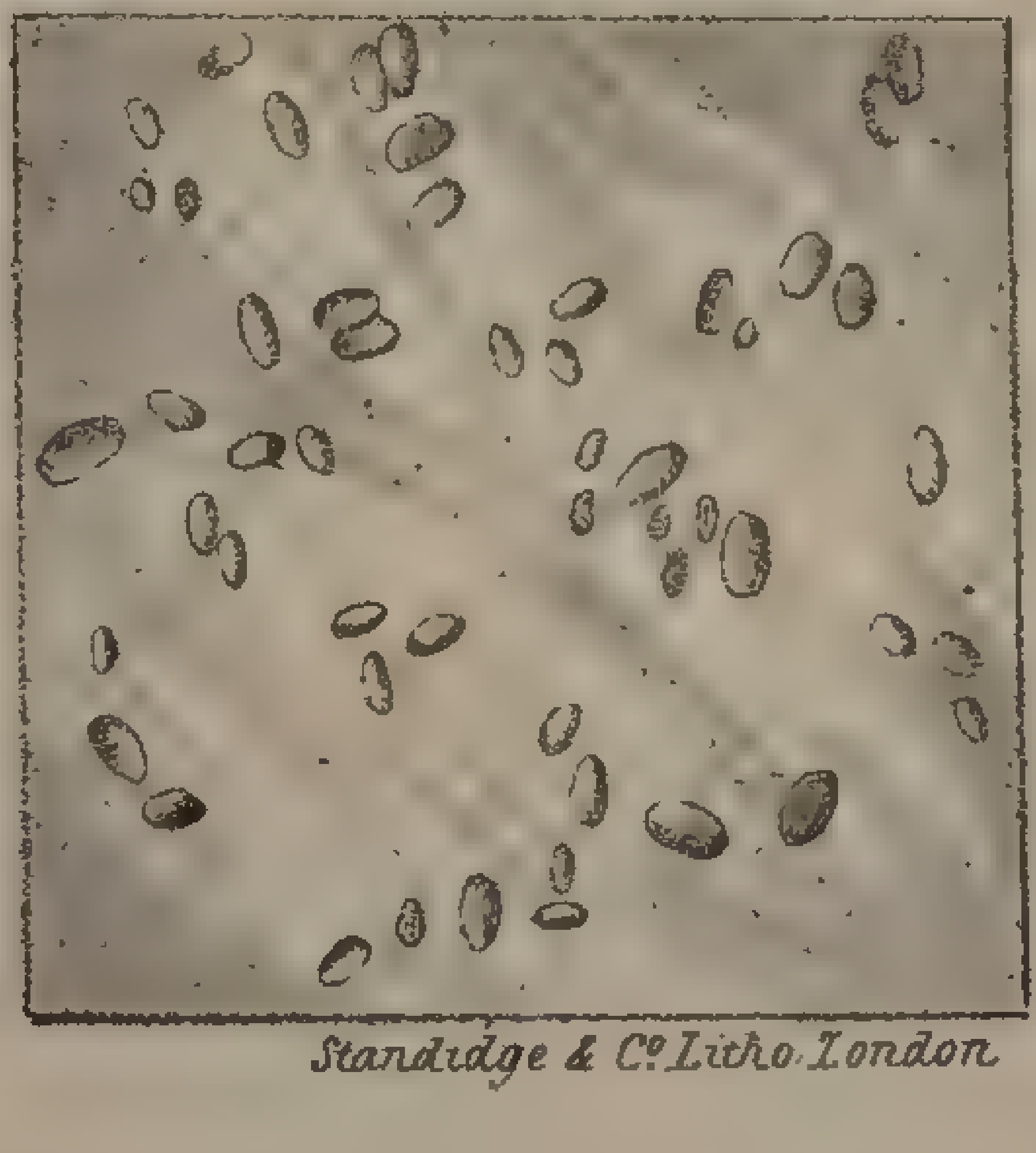












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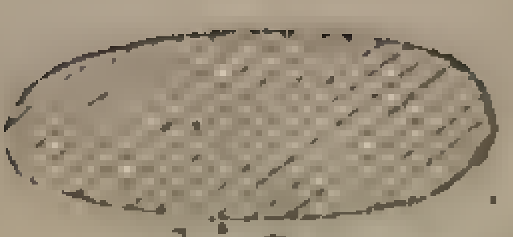
Pl. XXV.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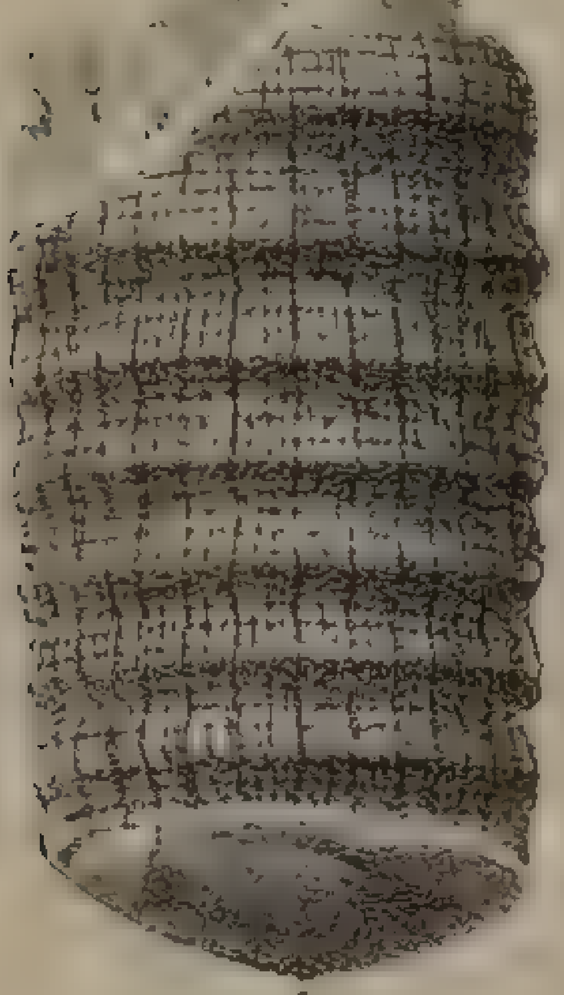

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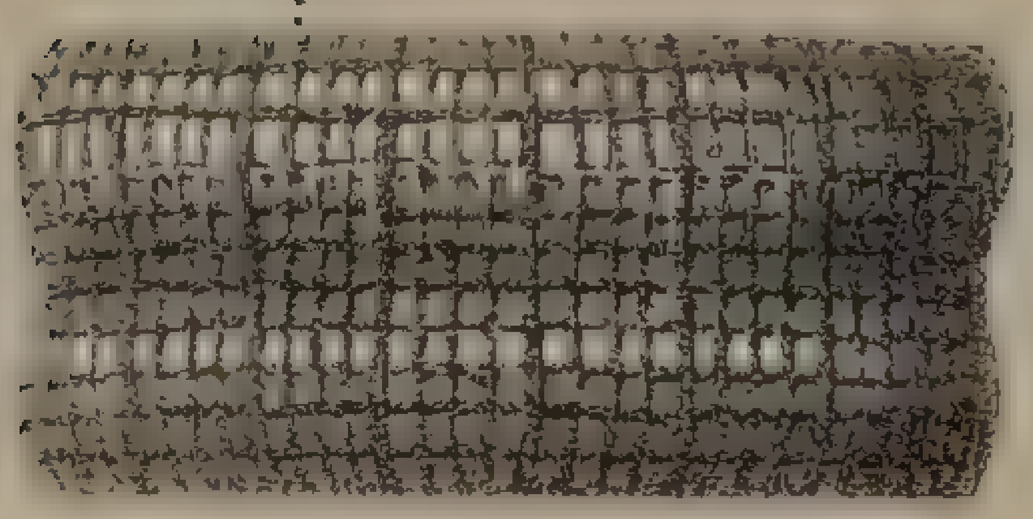

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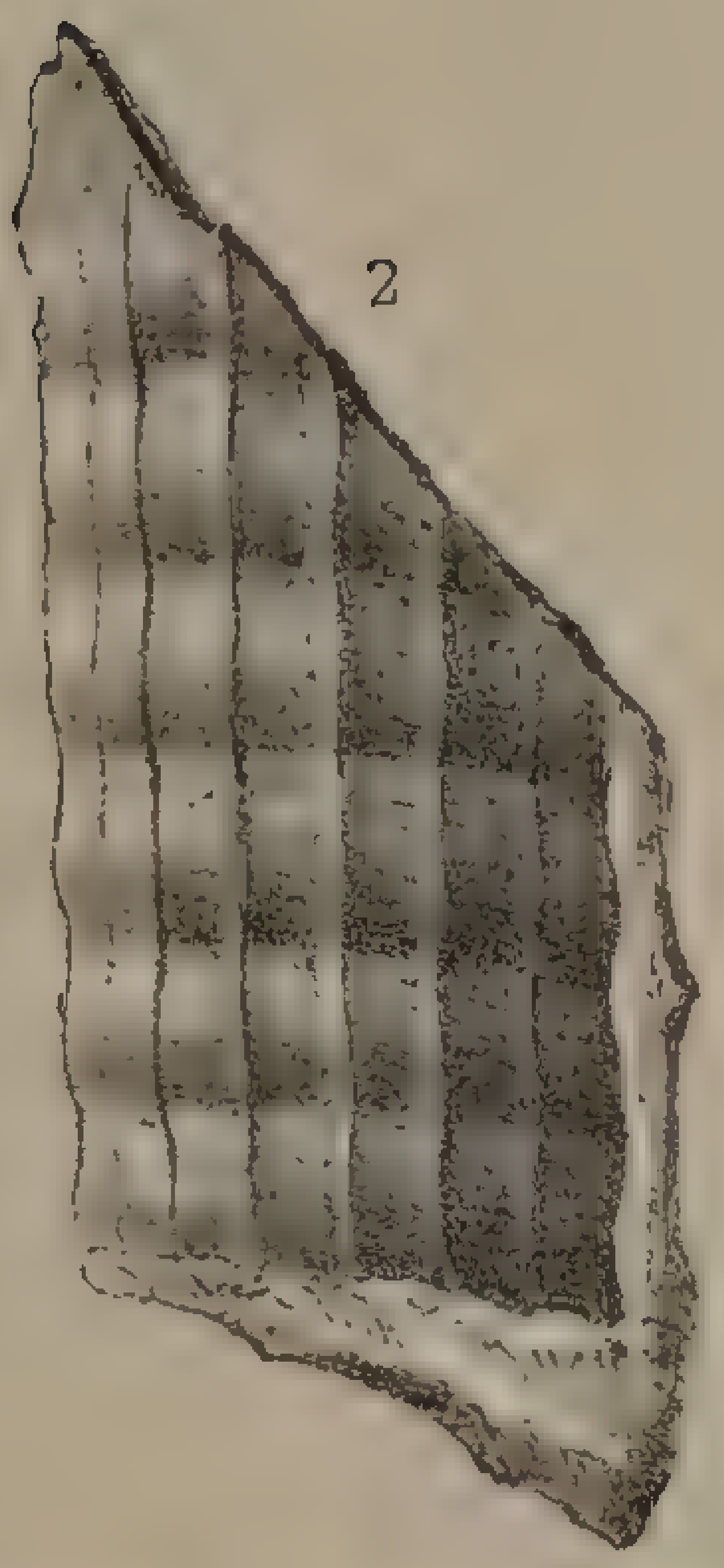

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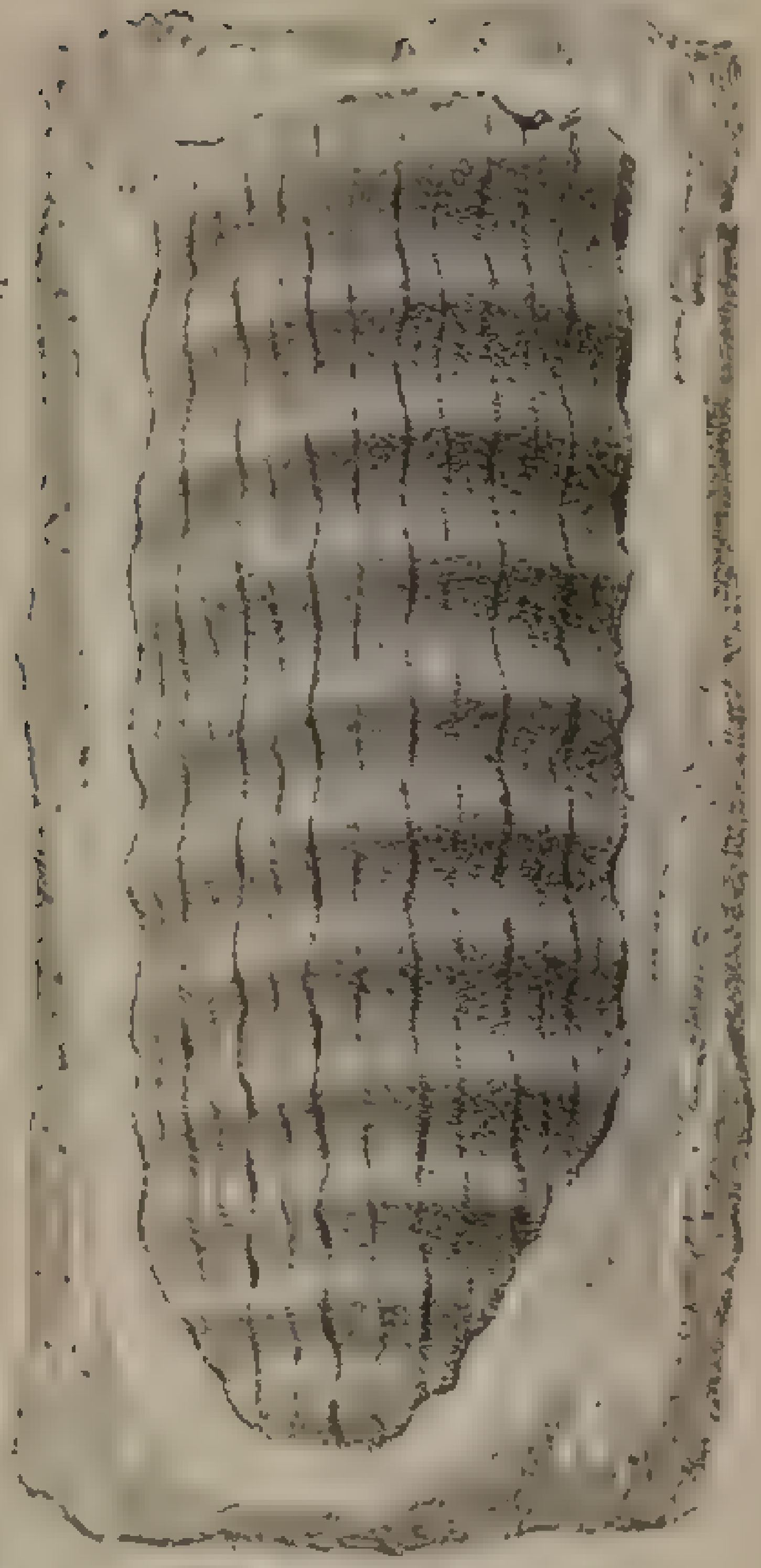
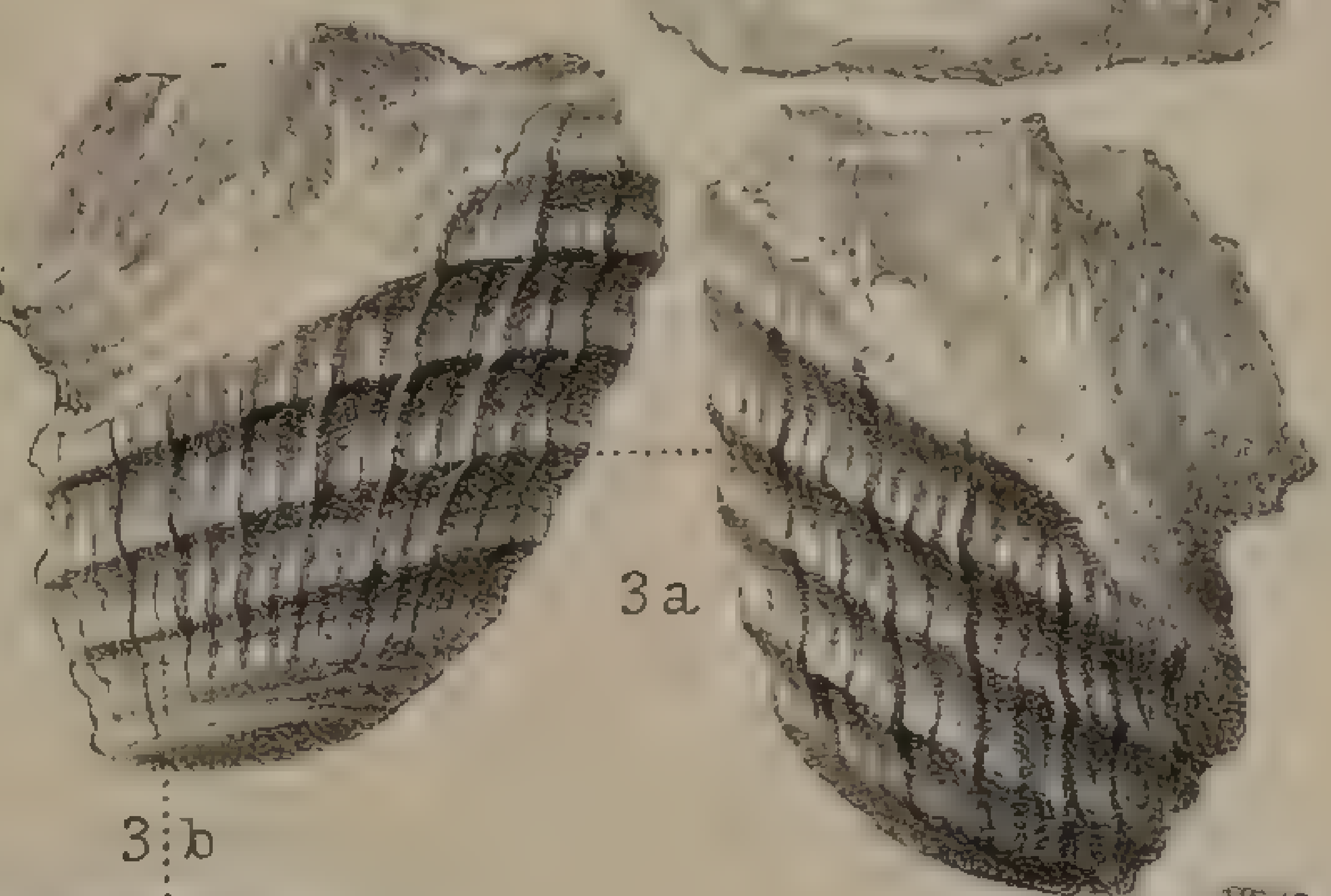
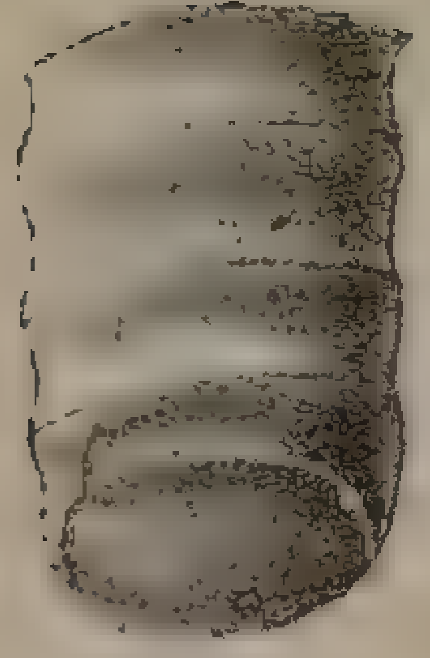



3 a

3 b

7



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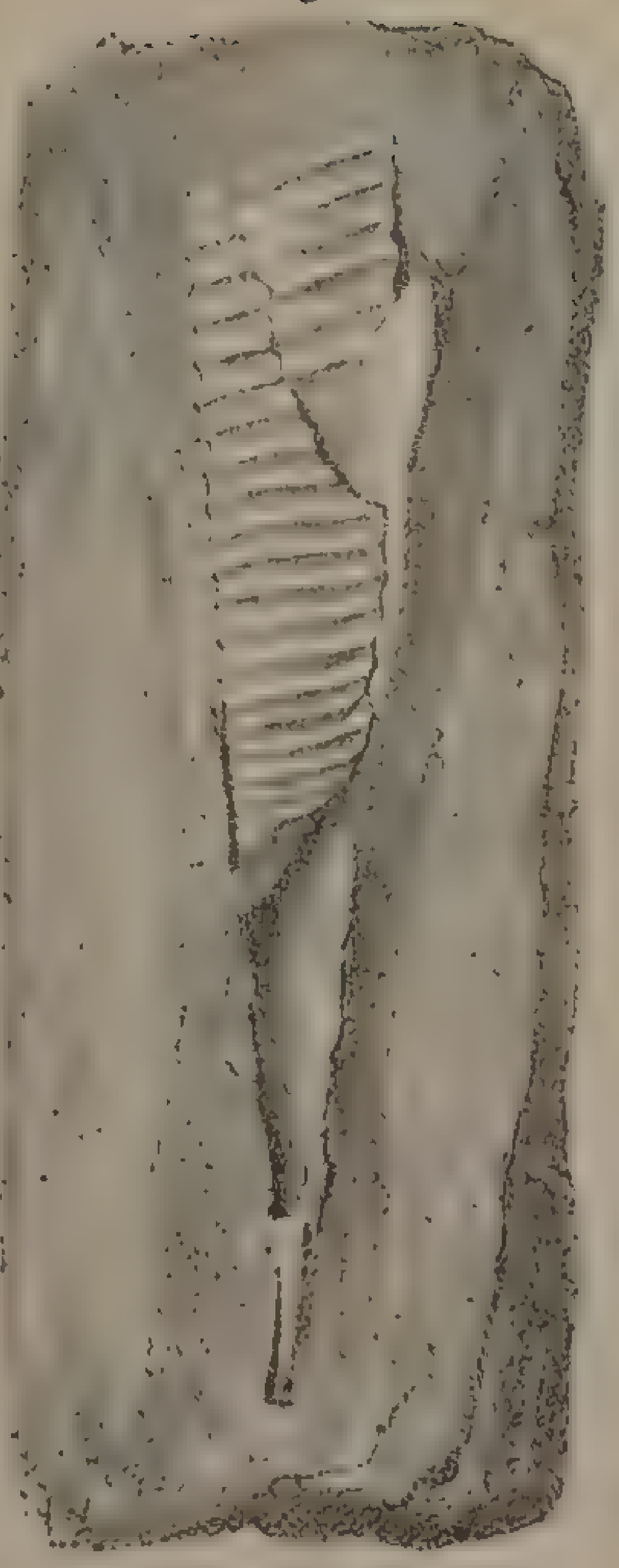

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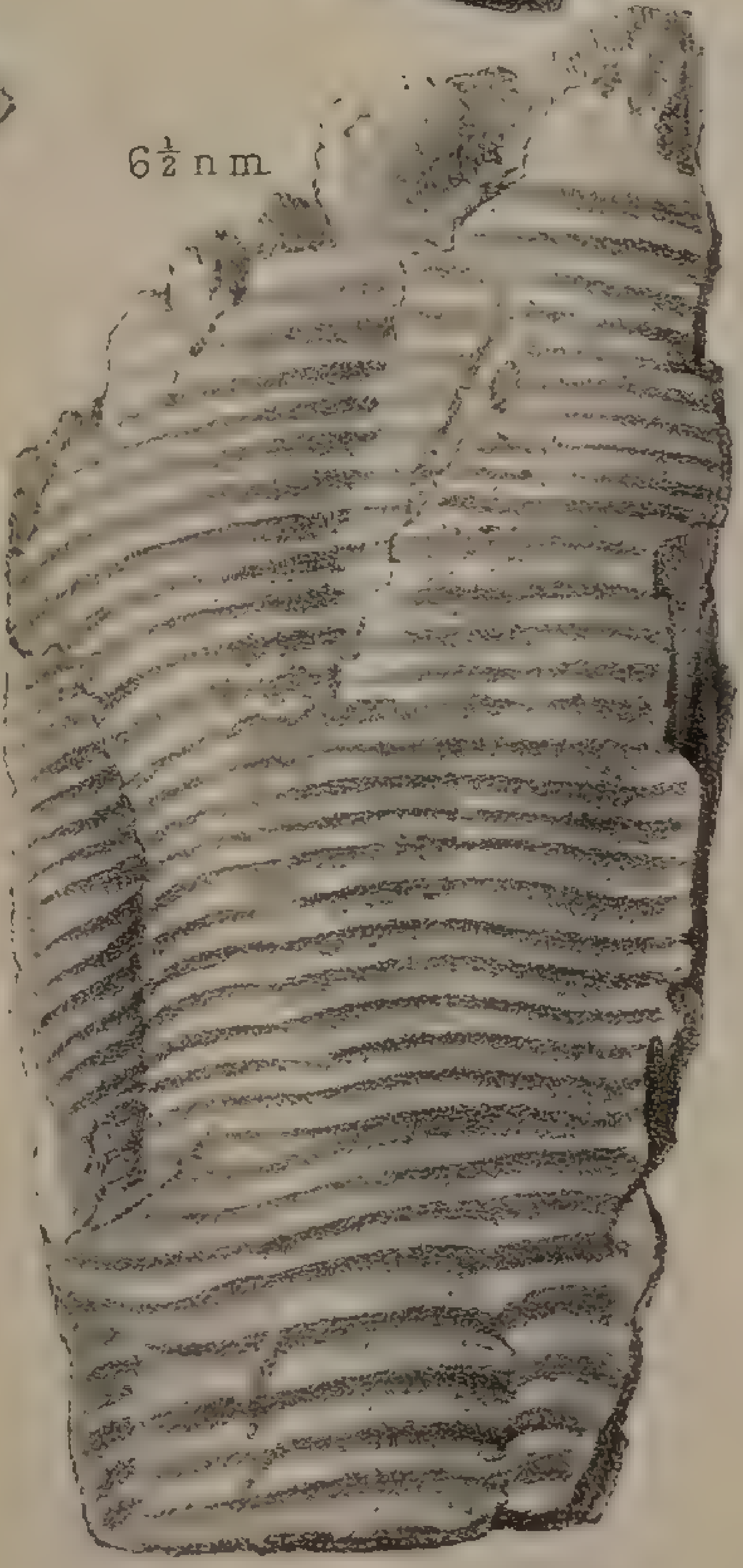

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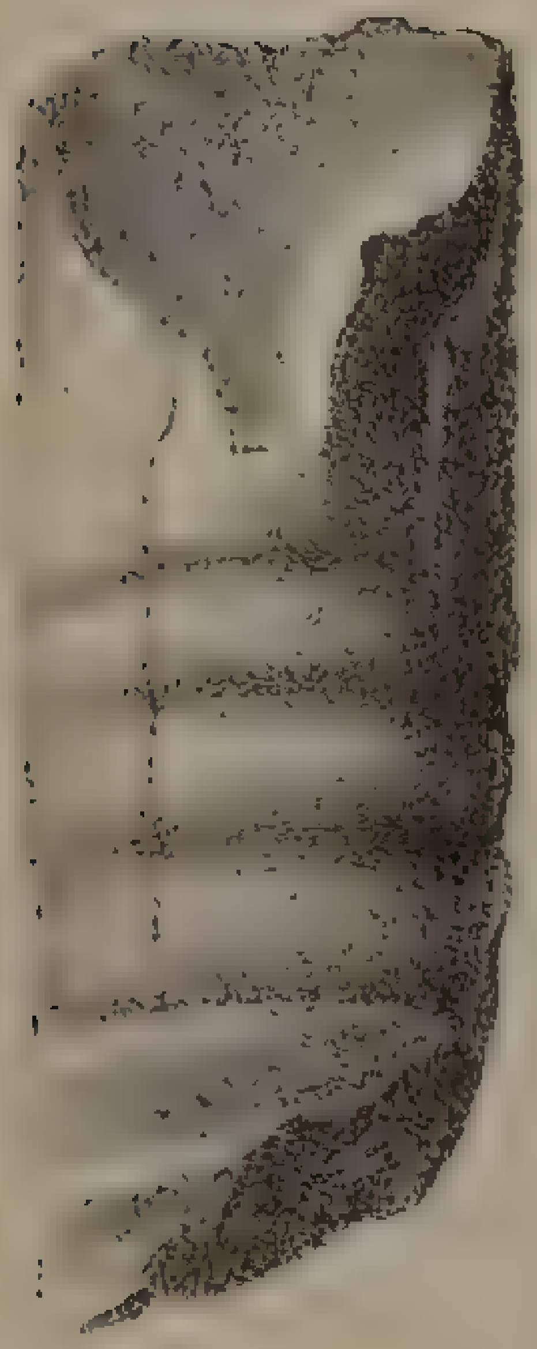

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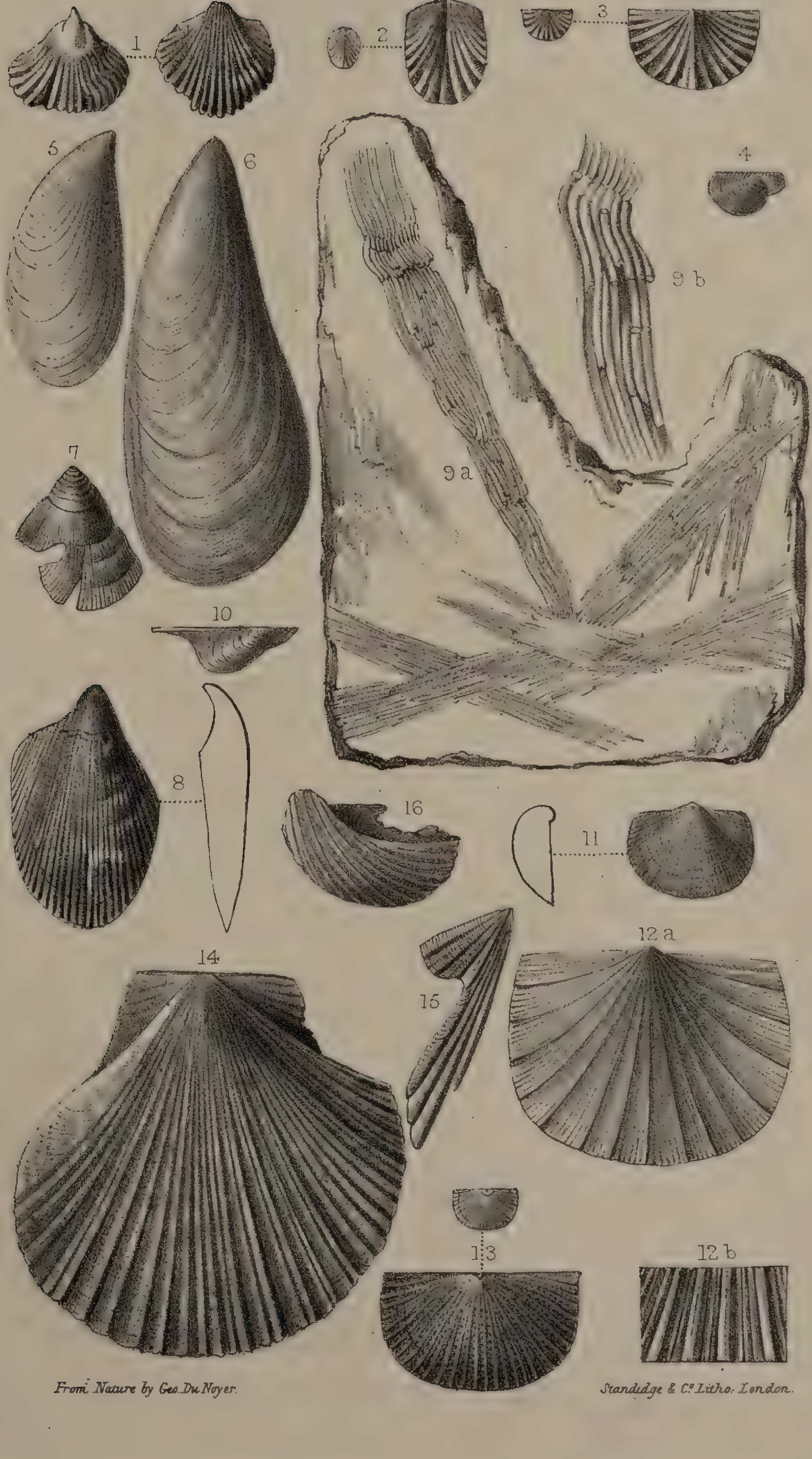
Pl XXV. A



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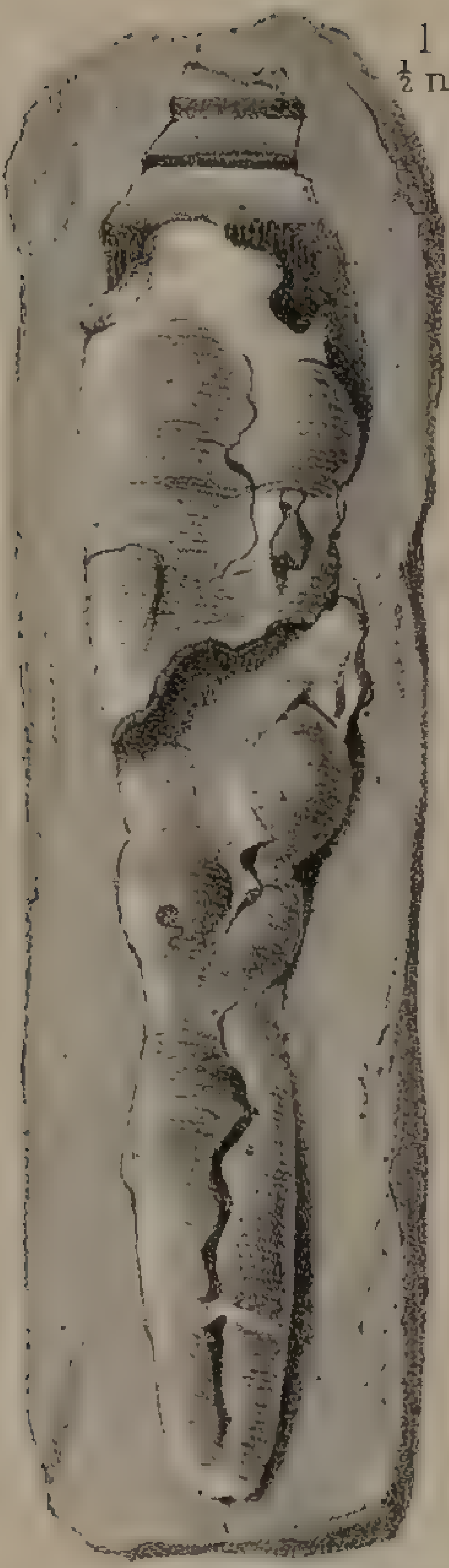
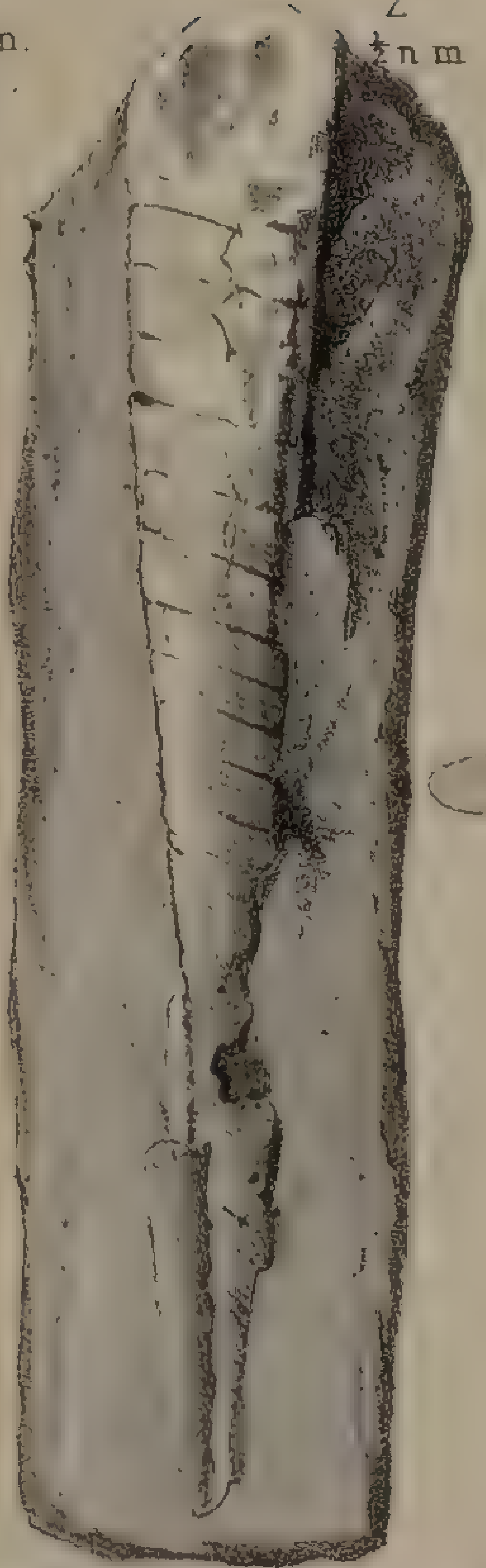
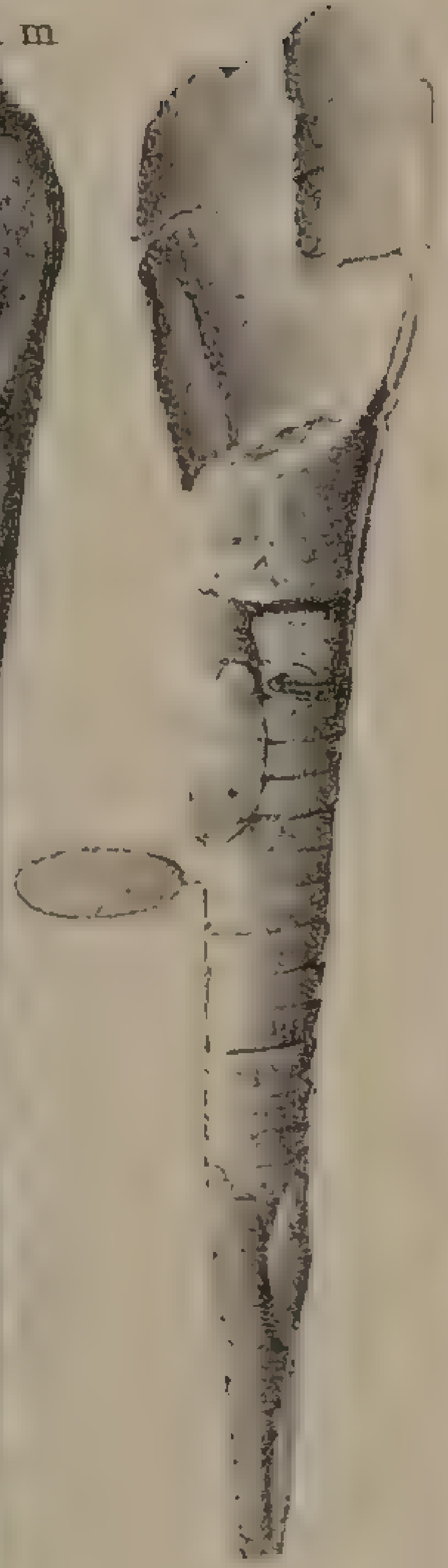
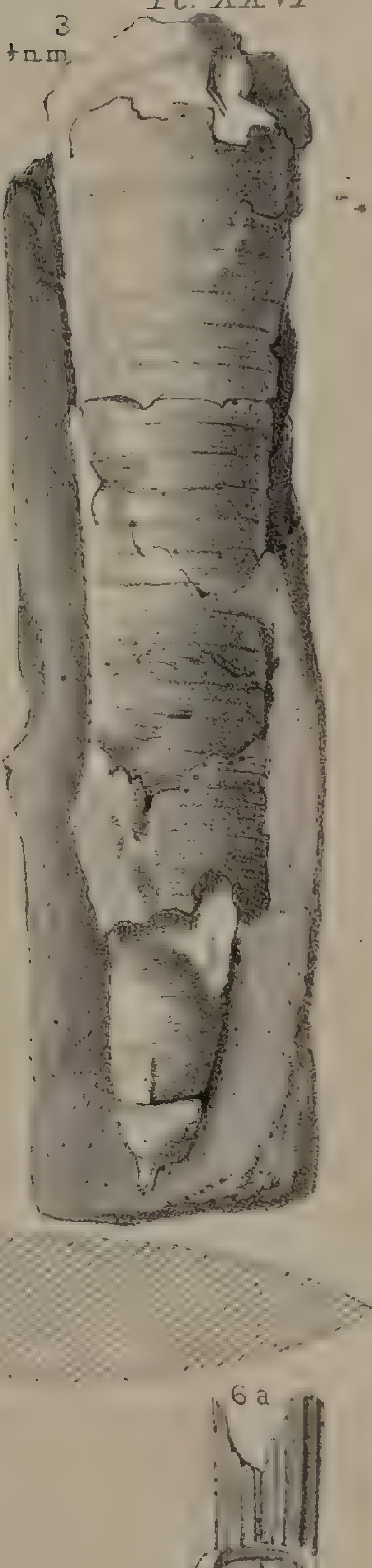
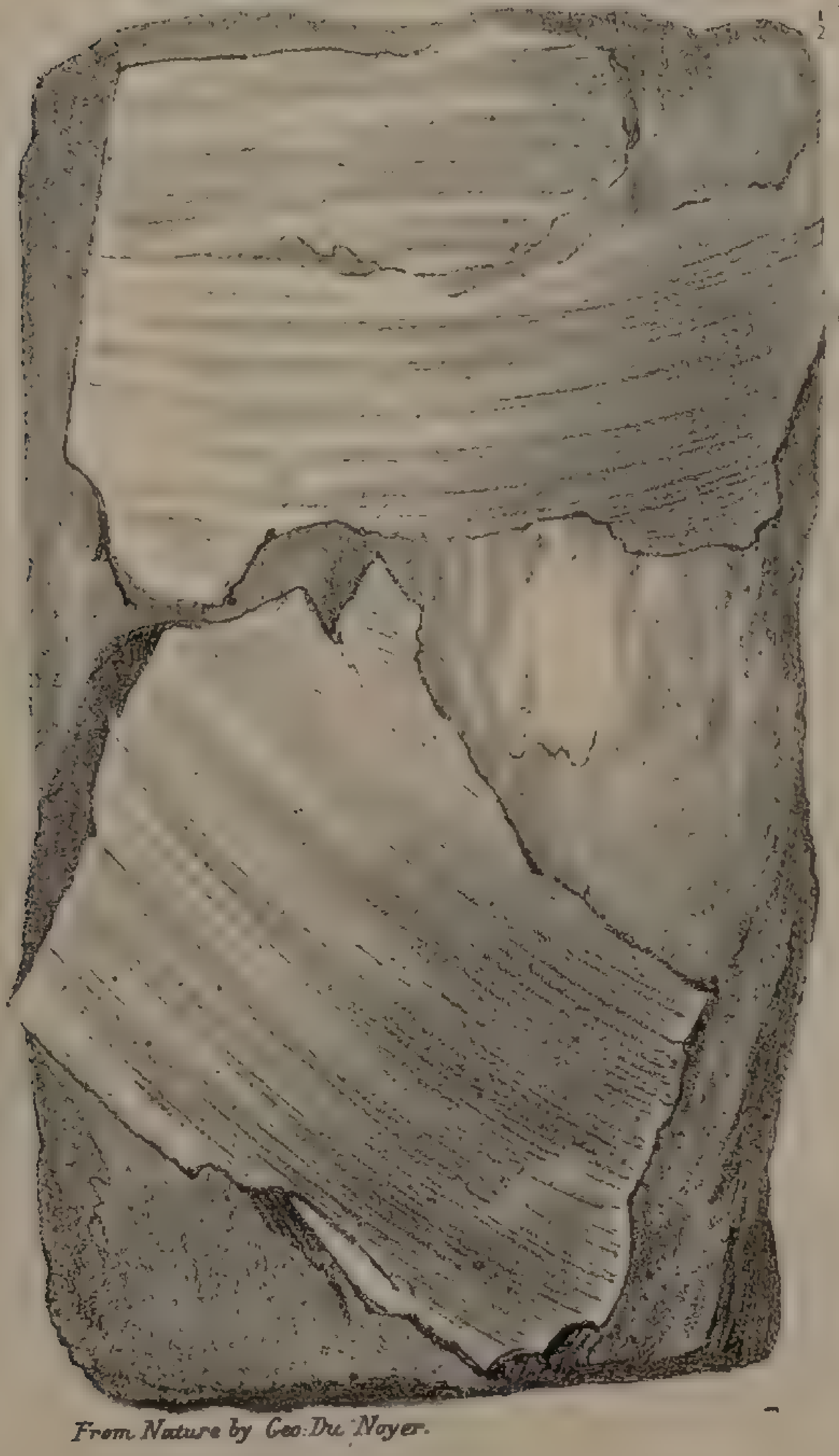
Pl. XXVI

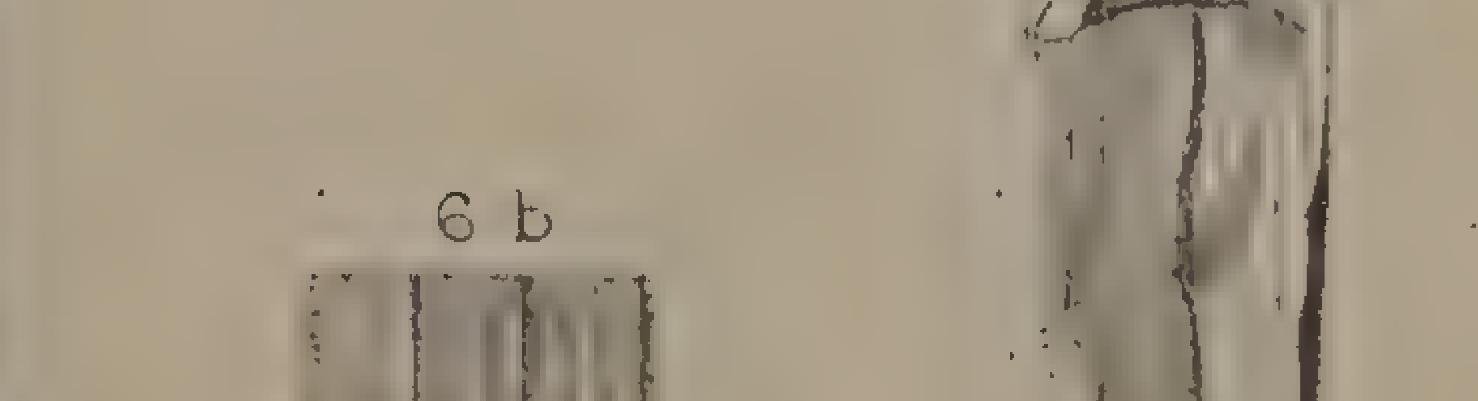


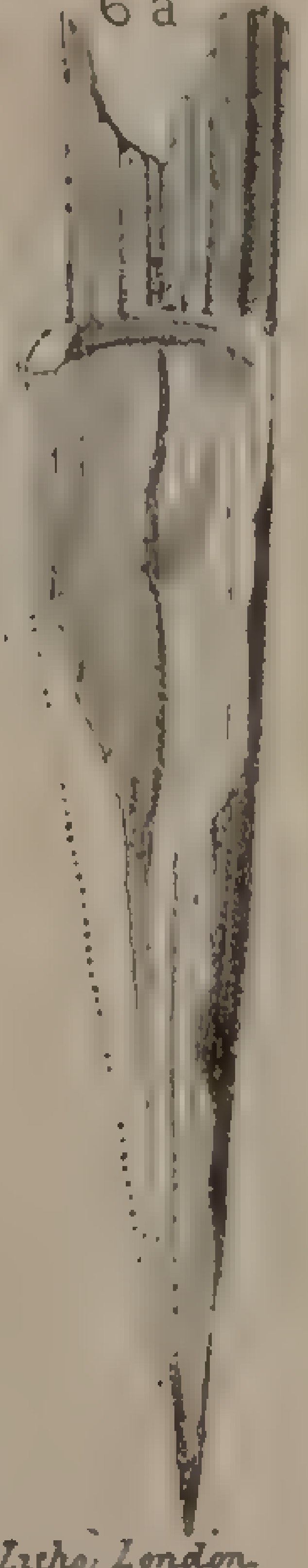


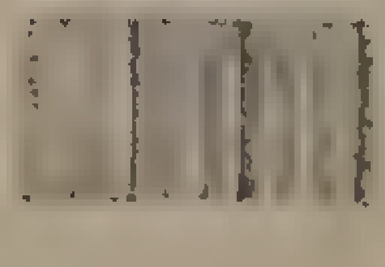












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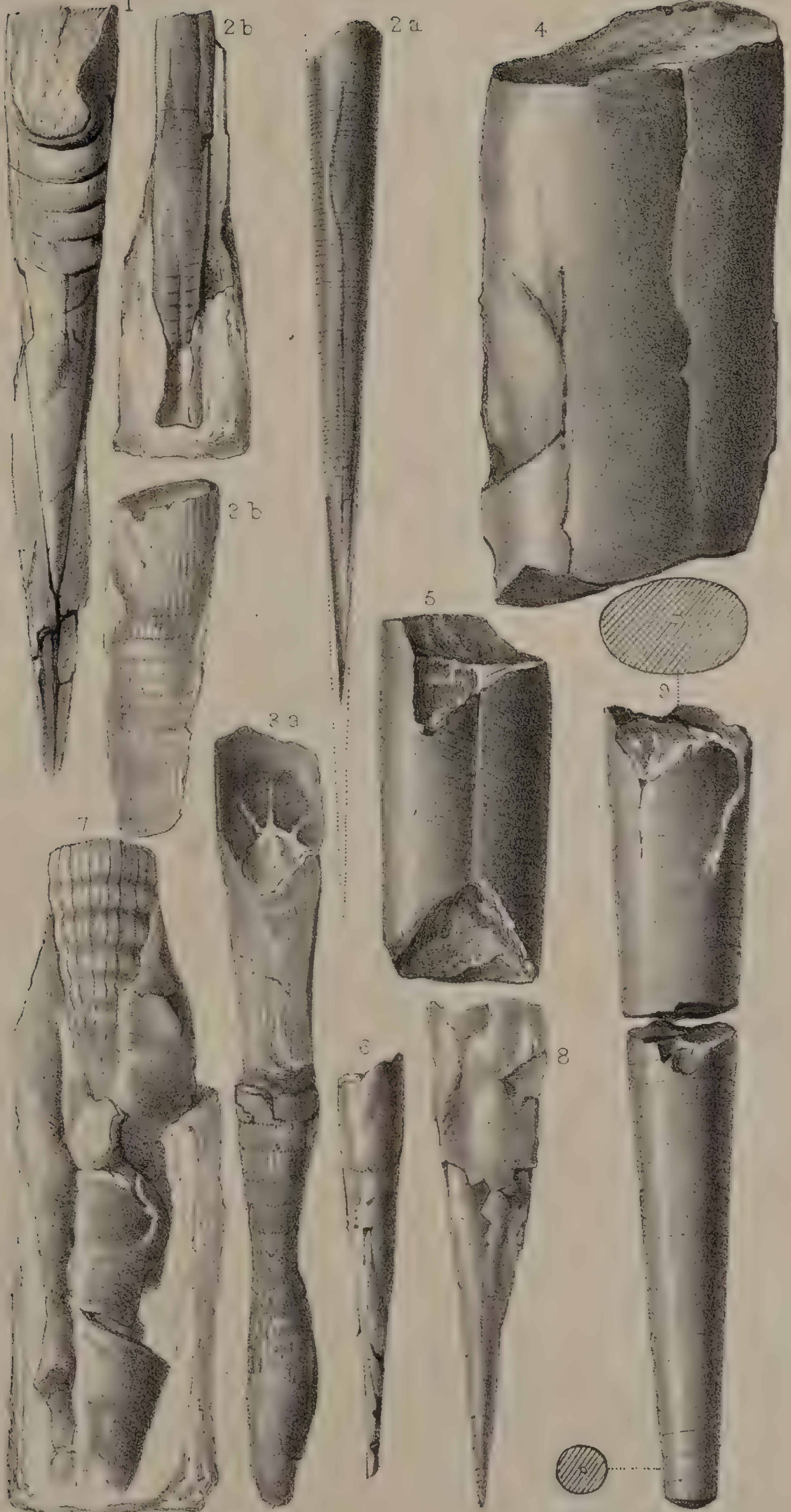
Pl. XXVII



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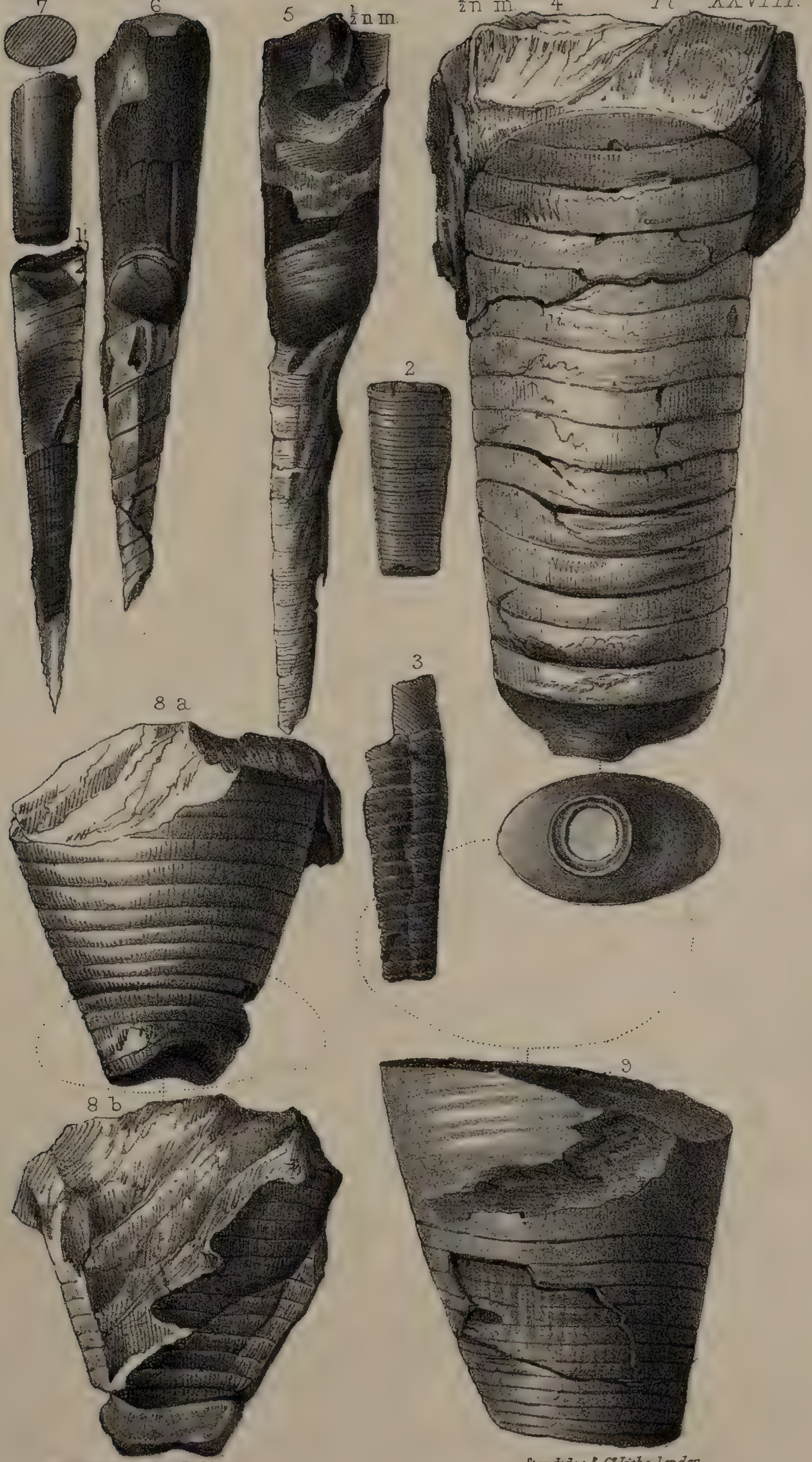
Pl XXVIII.



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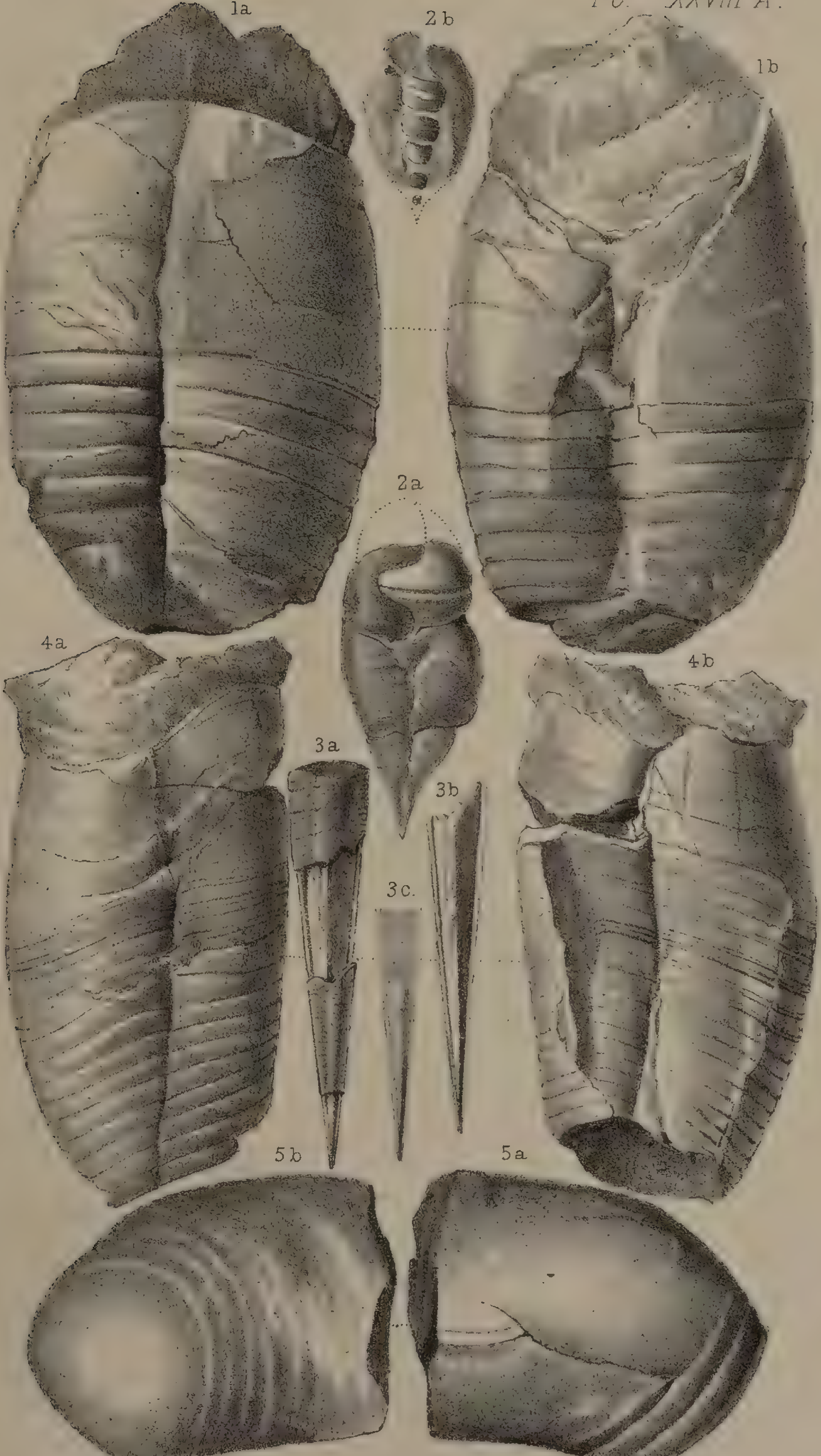
Pl. XXVIII A.



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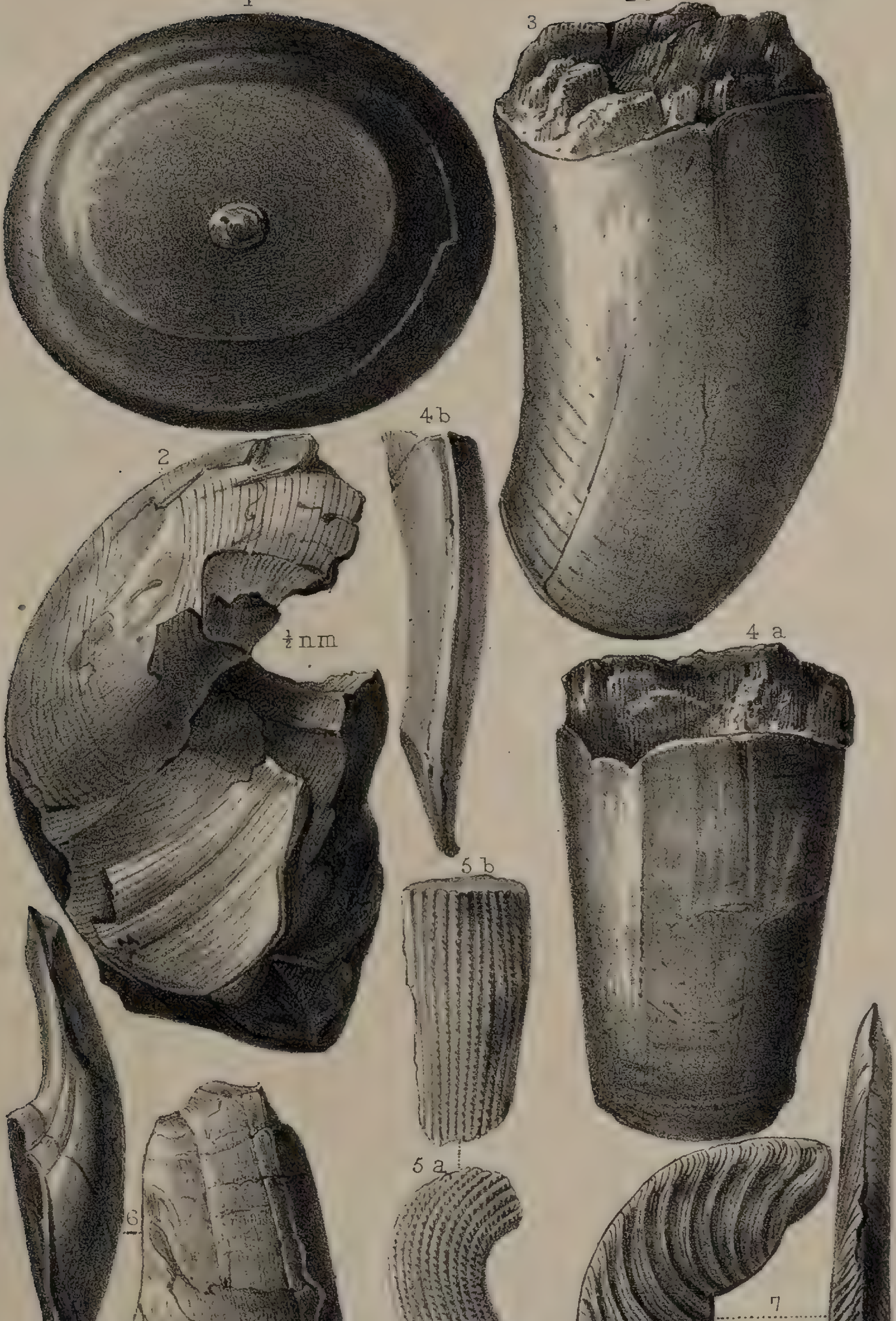
Pl. XXVIII. B.



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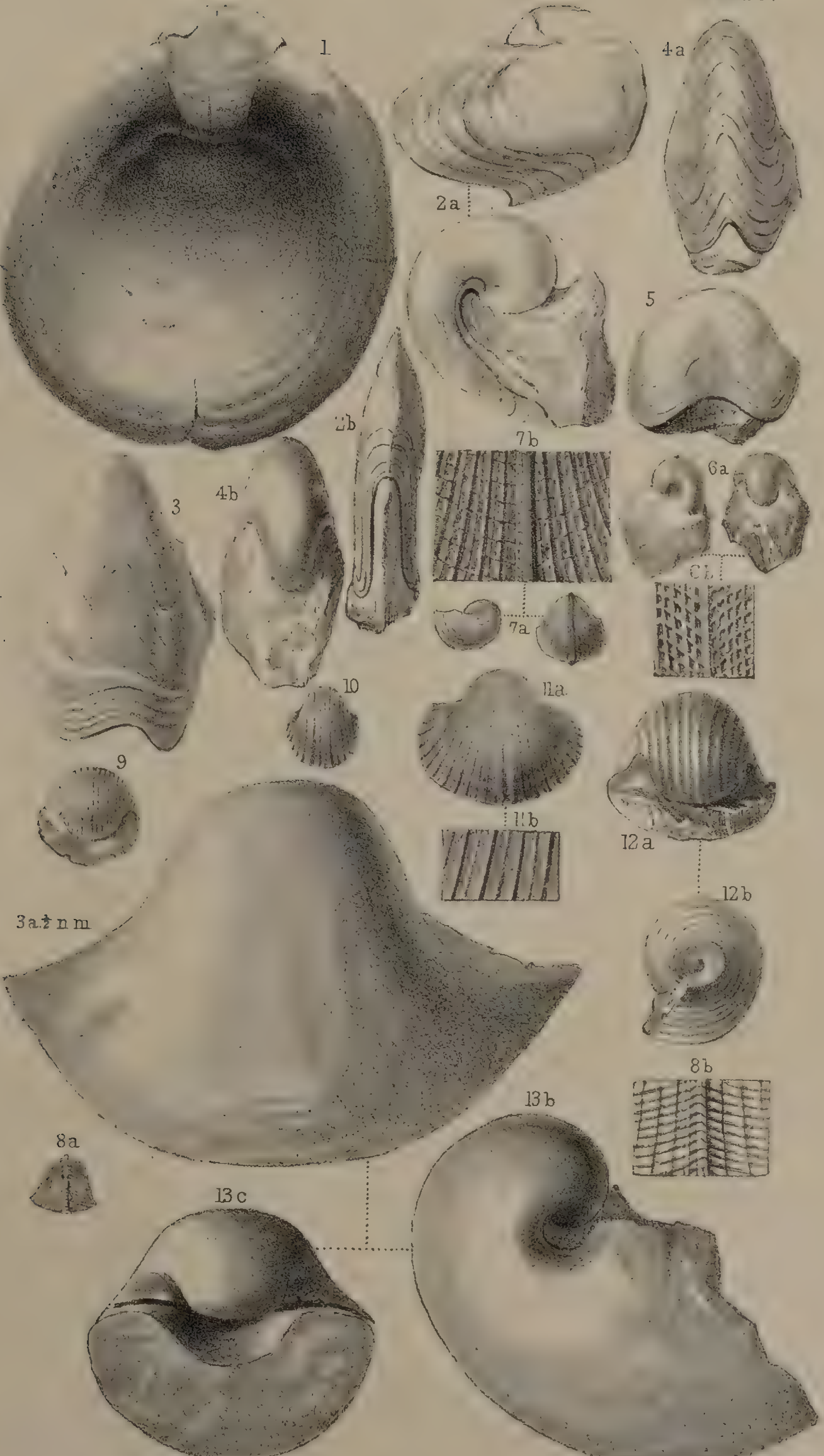
Pl. XXIX.



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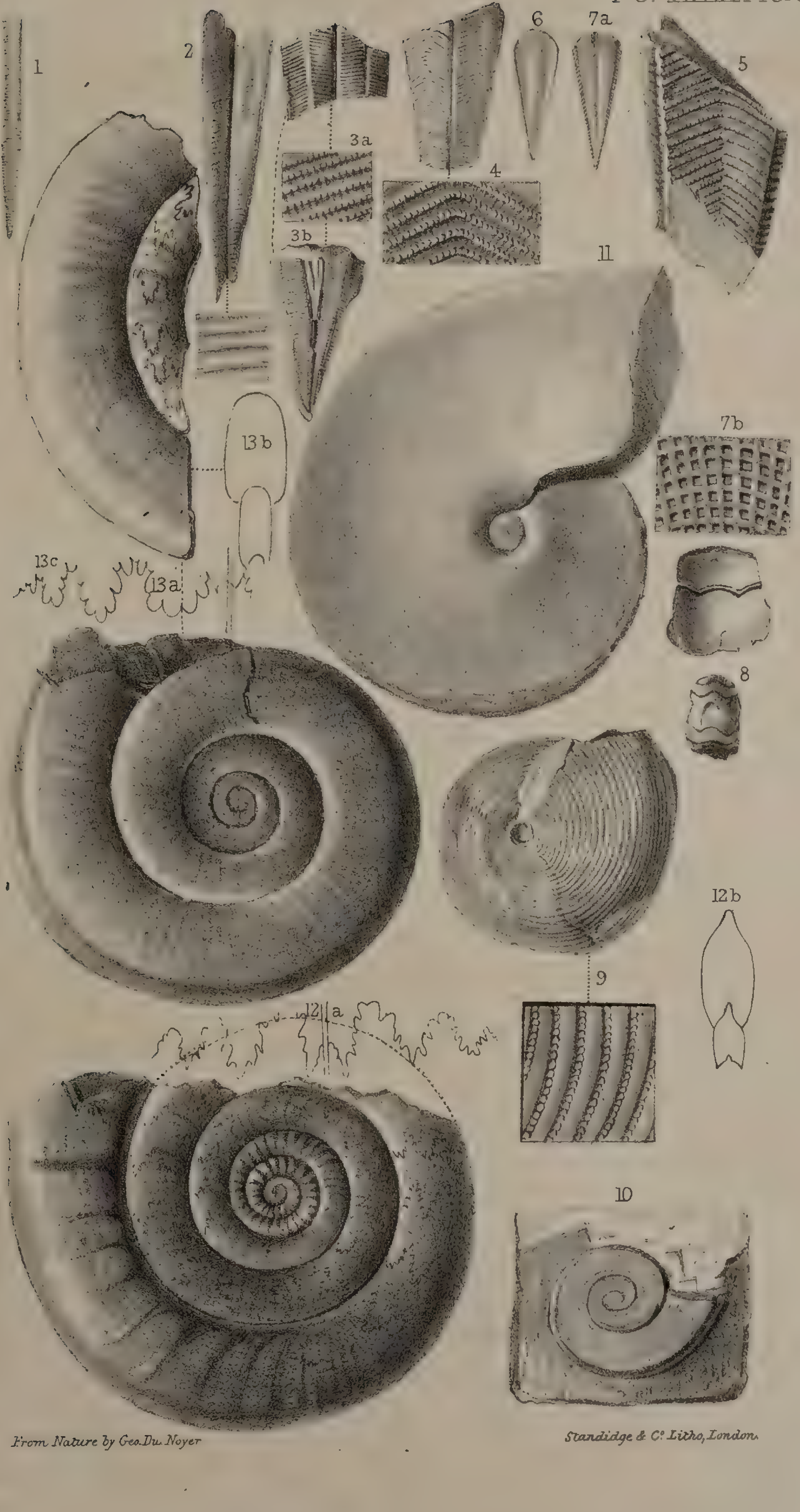
Pl. XXIX A &c



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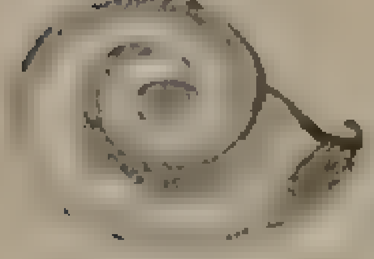

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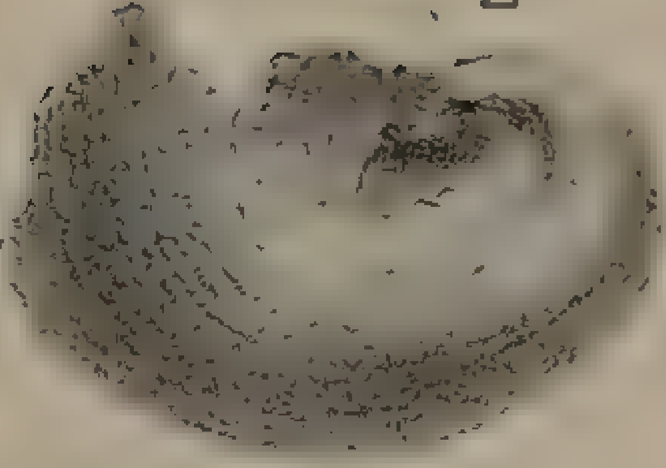

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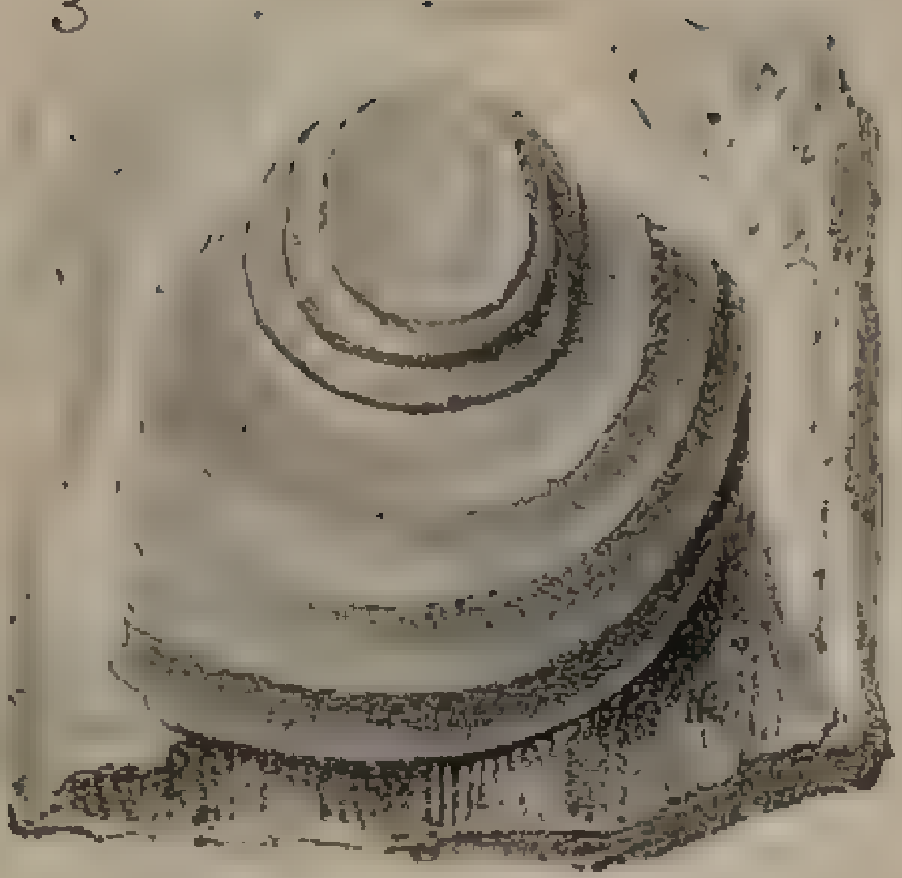

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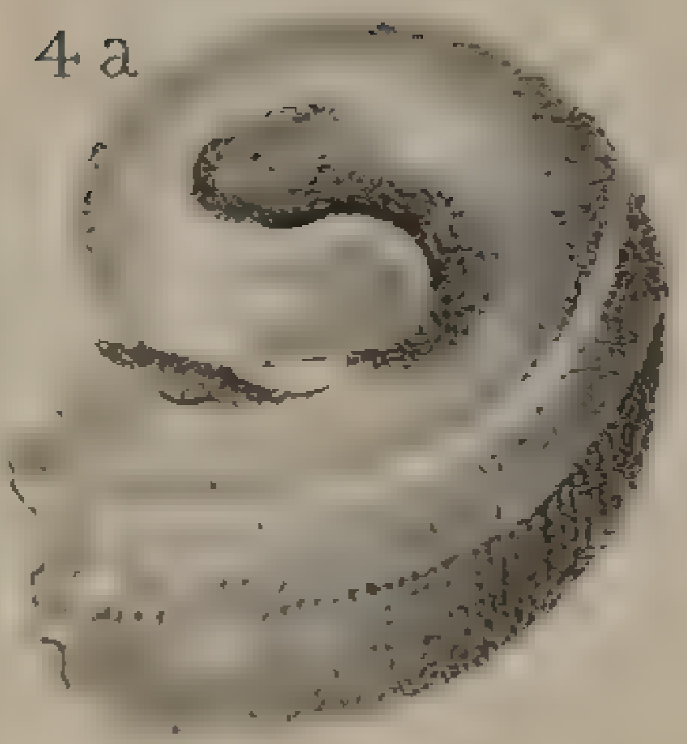

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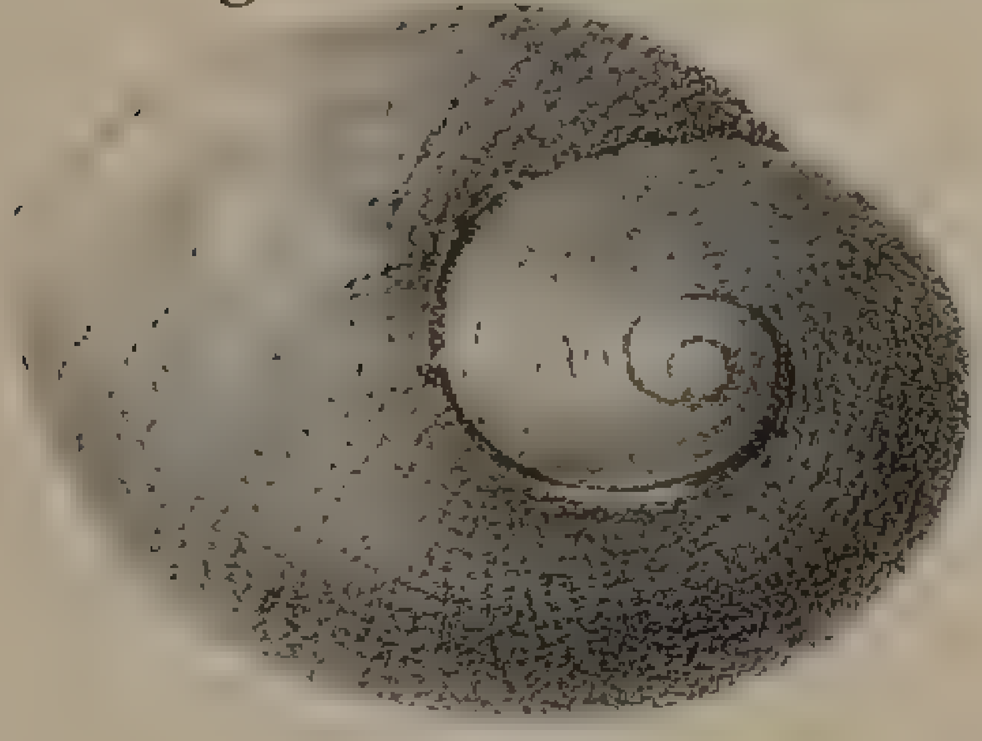

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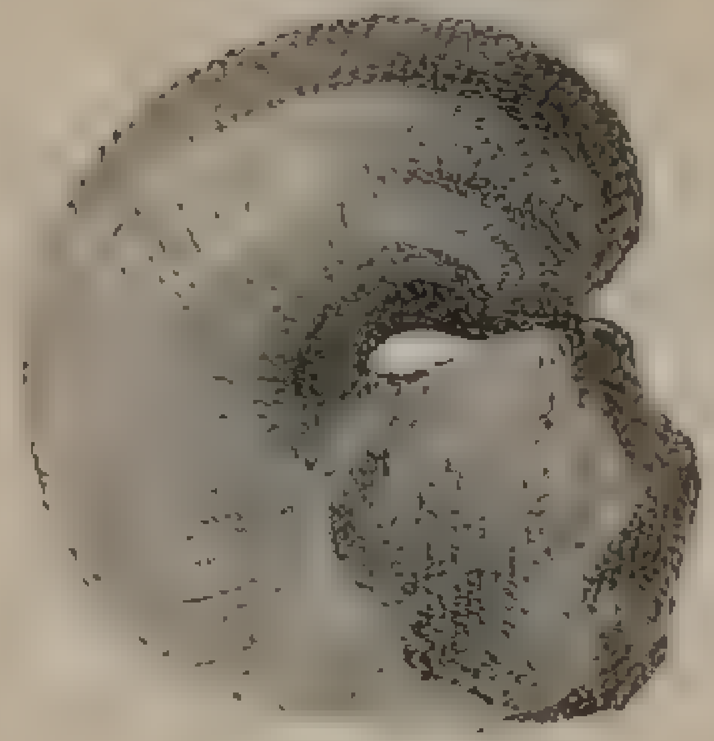

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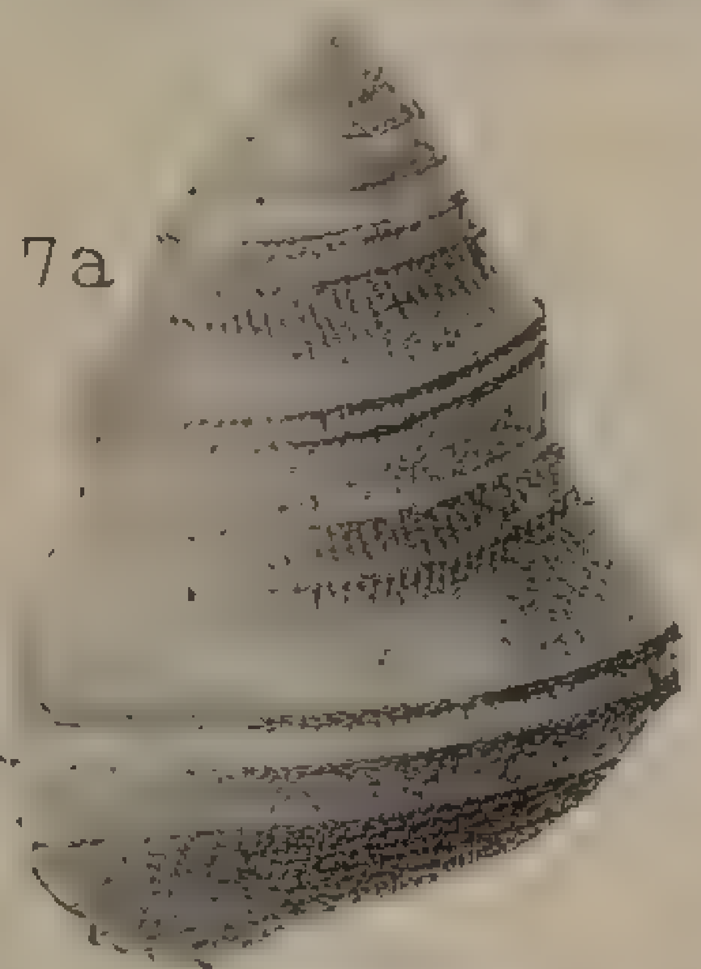

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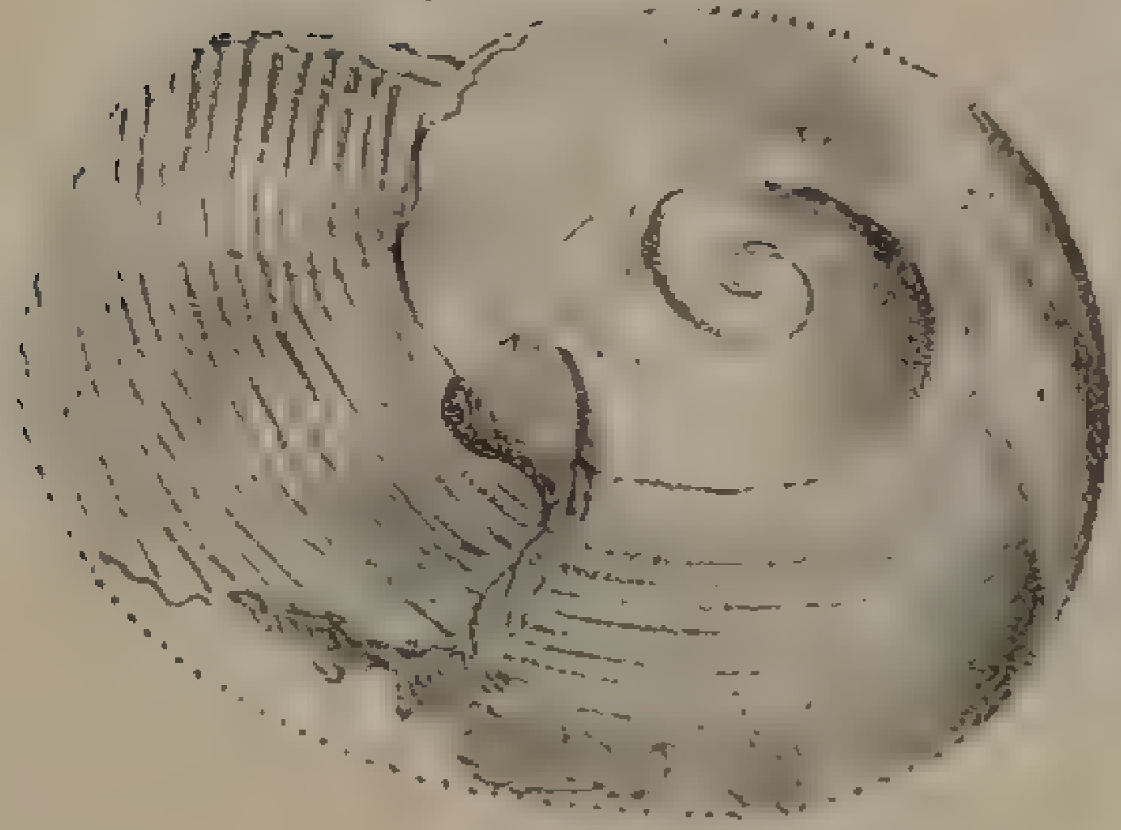

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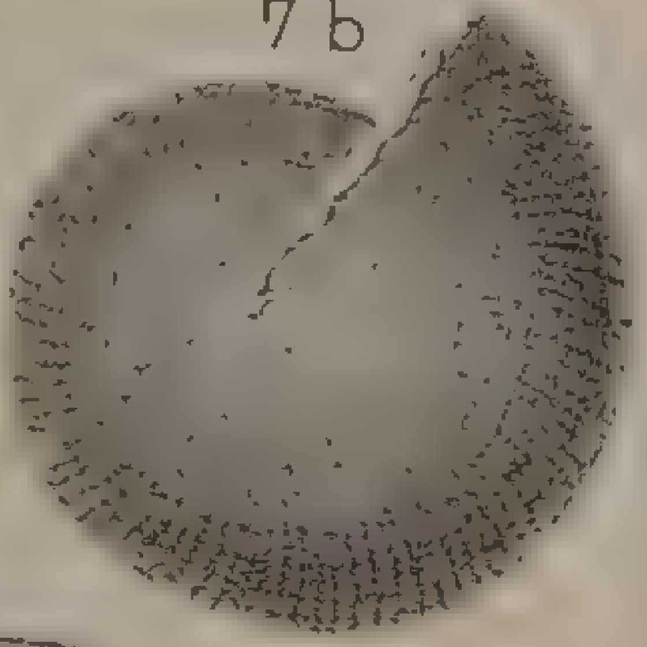

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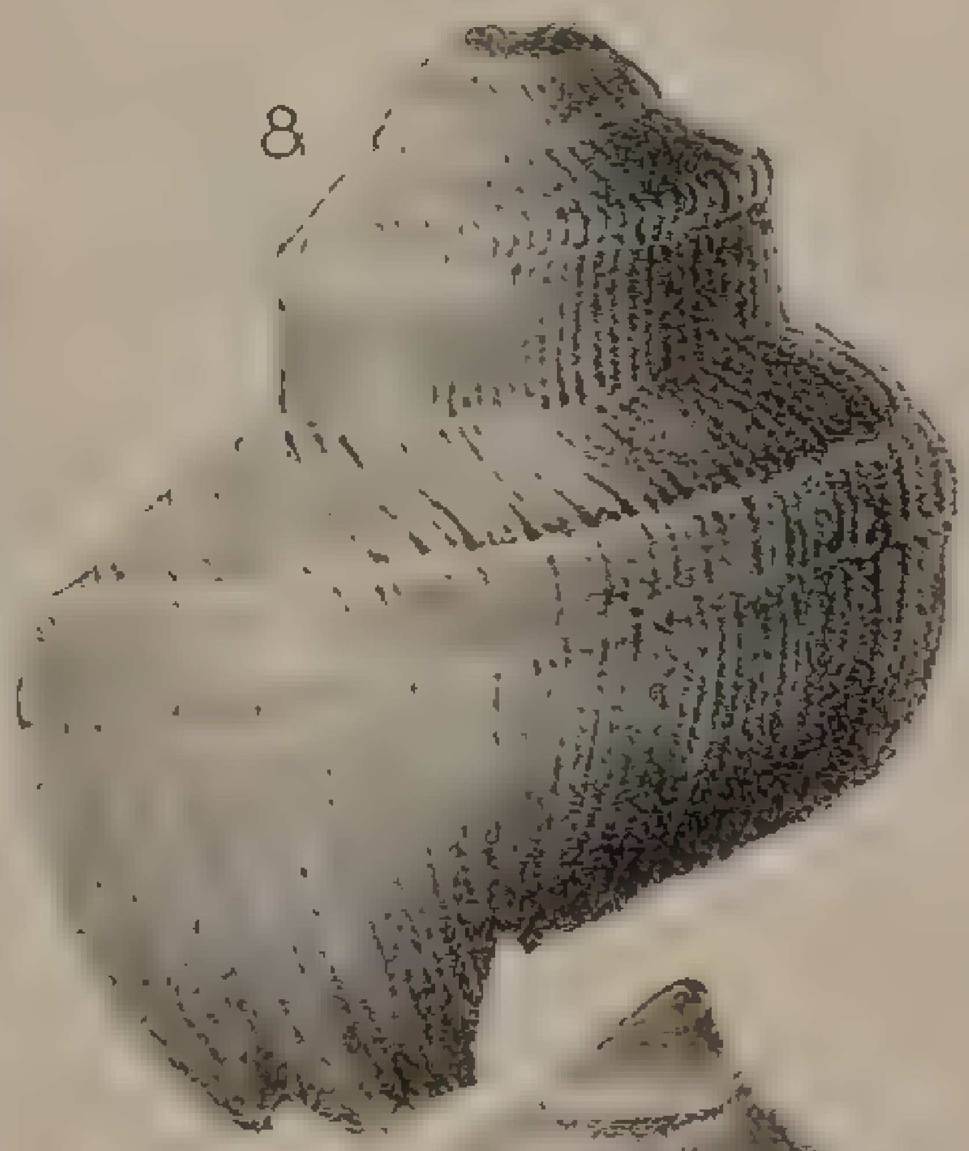

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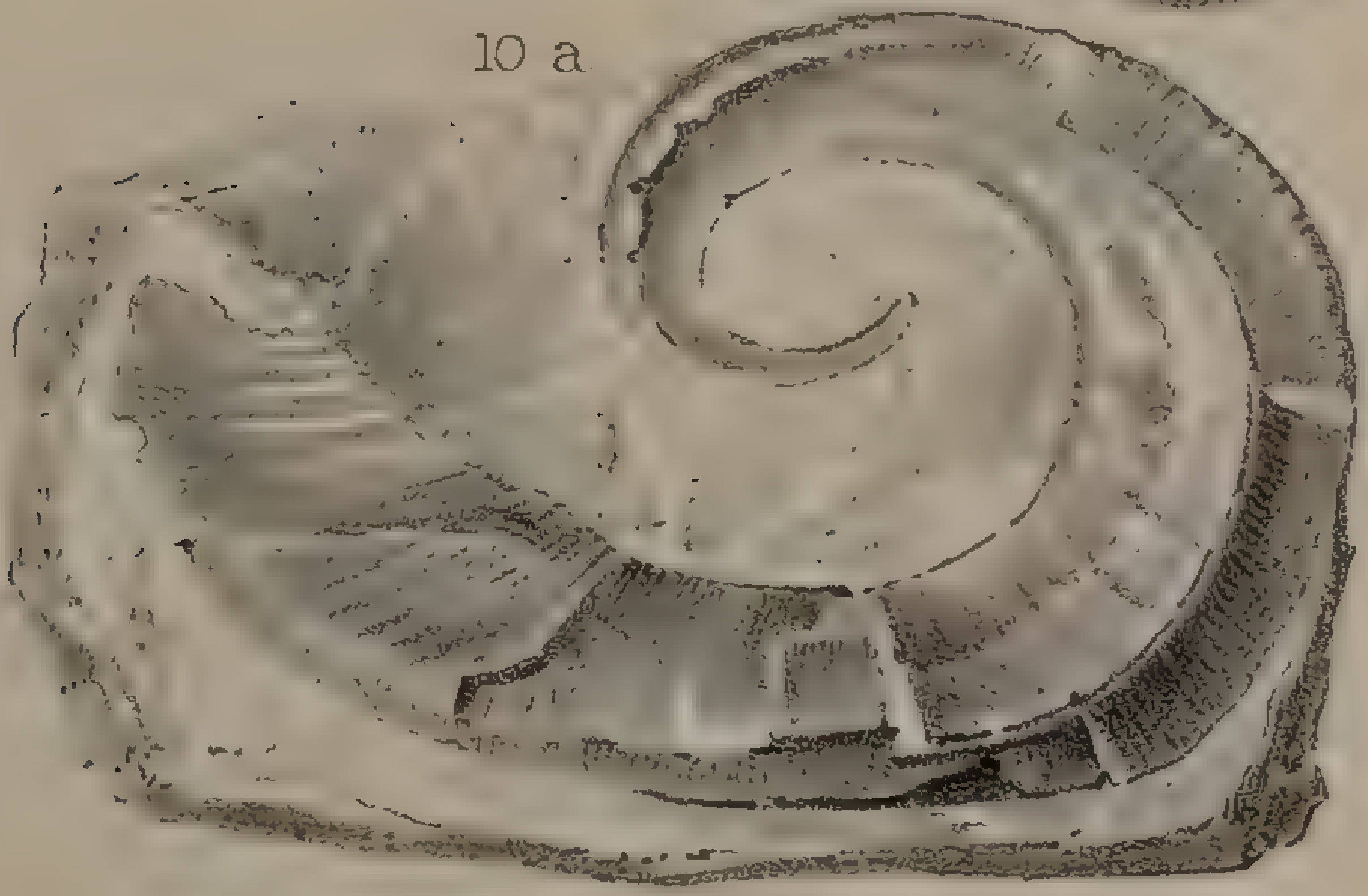

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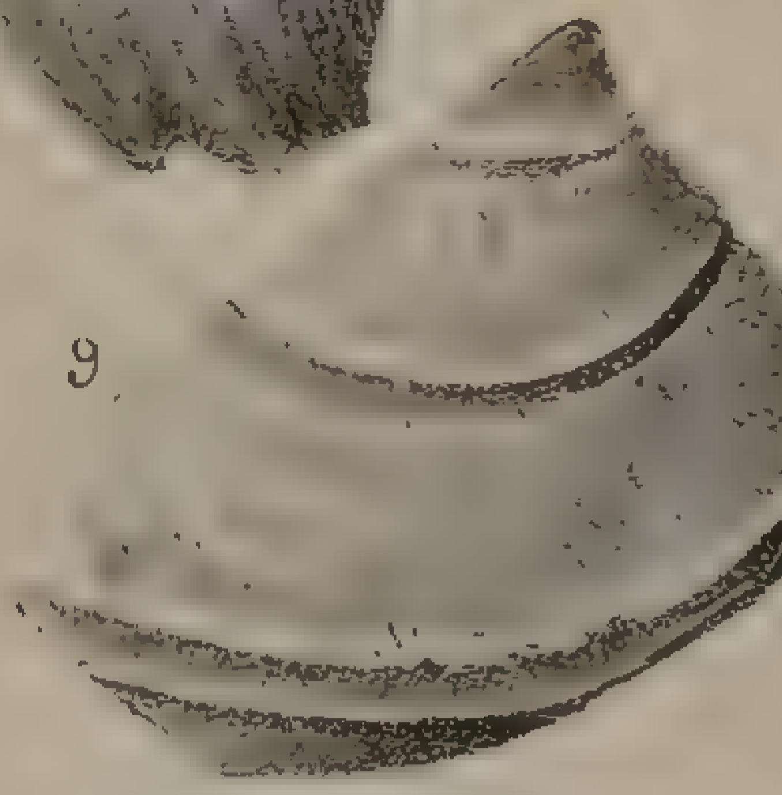

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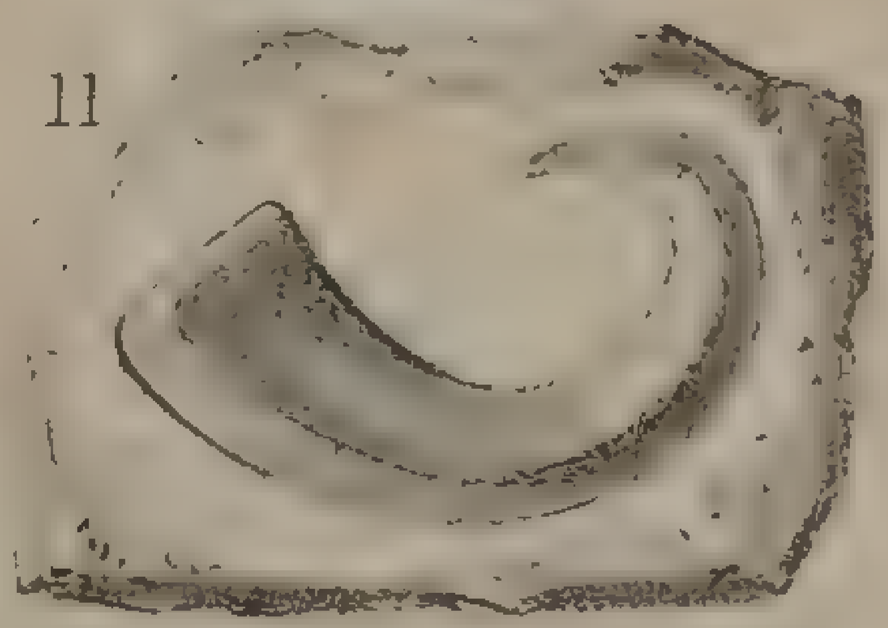

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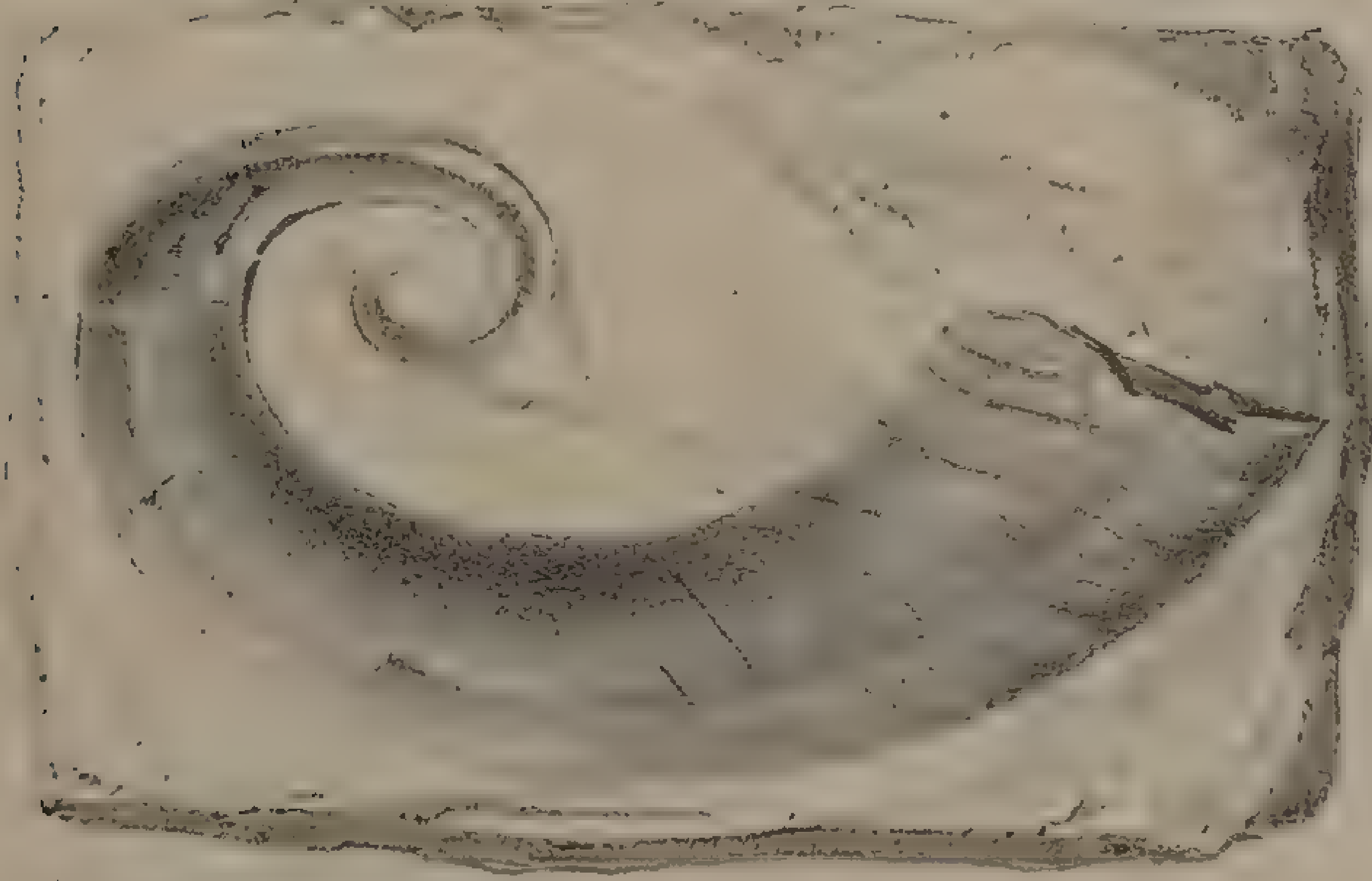

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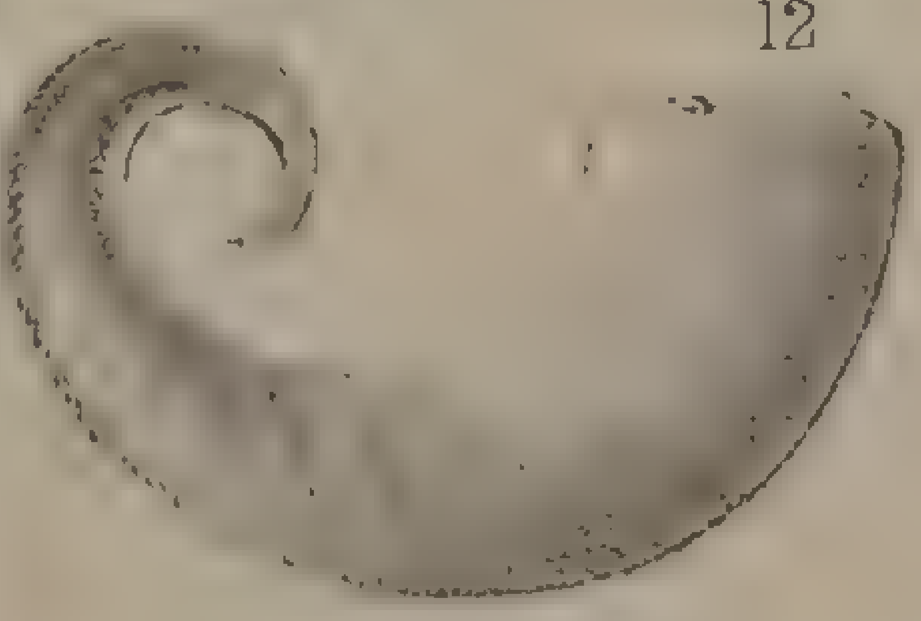

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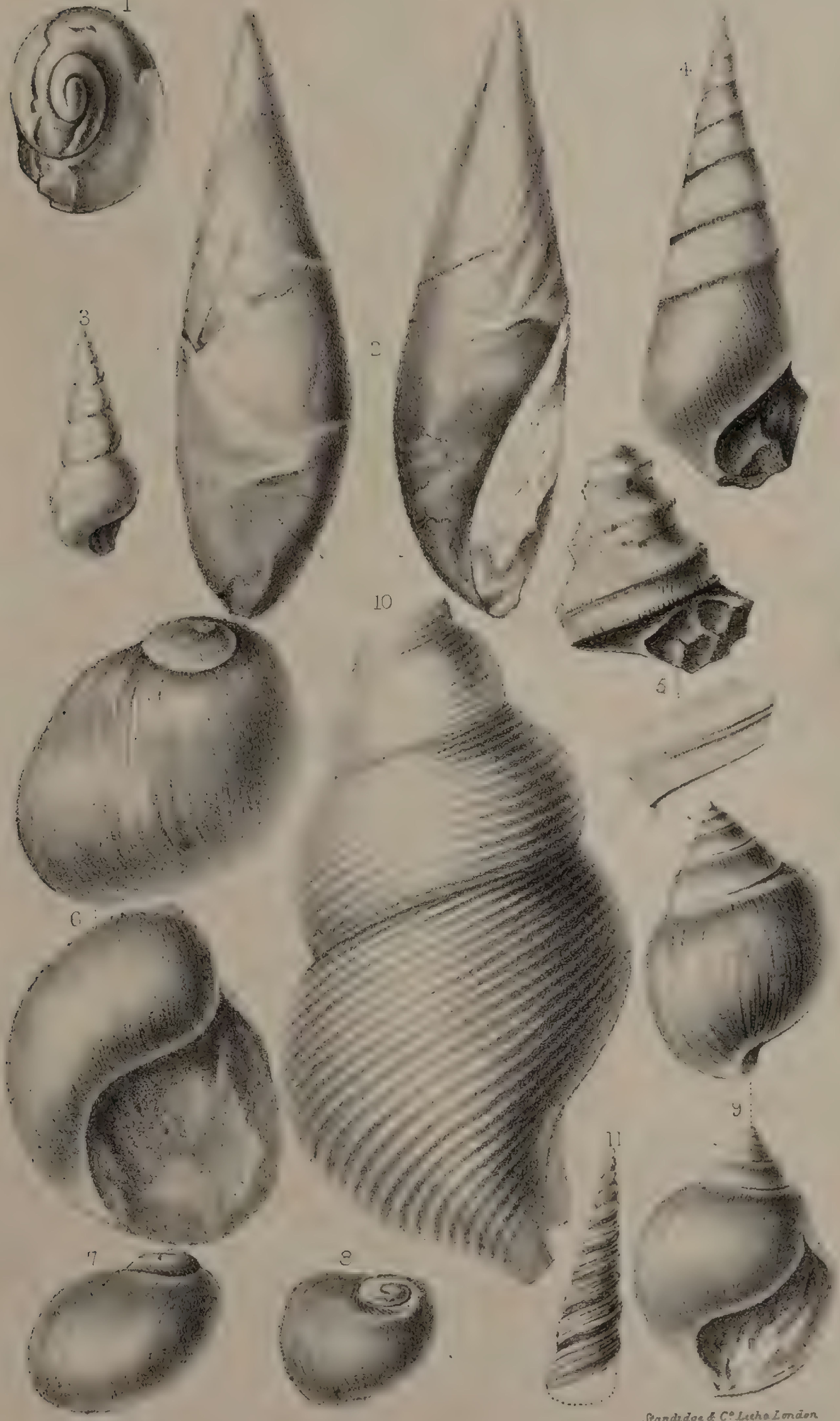
Pl. XXXI



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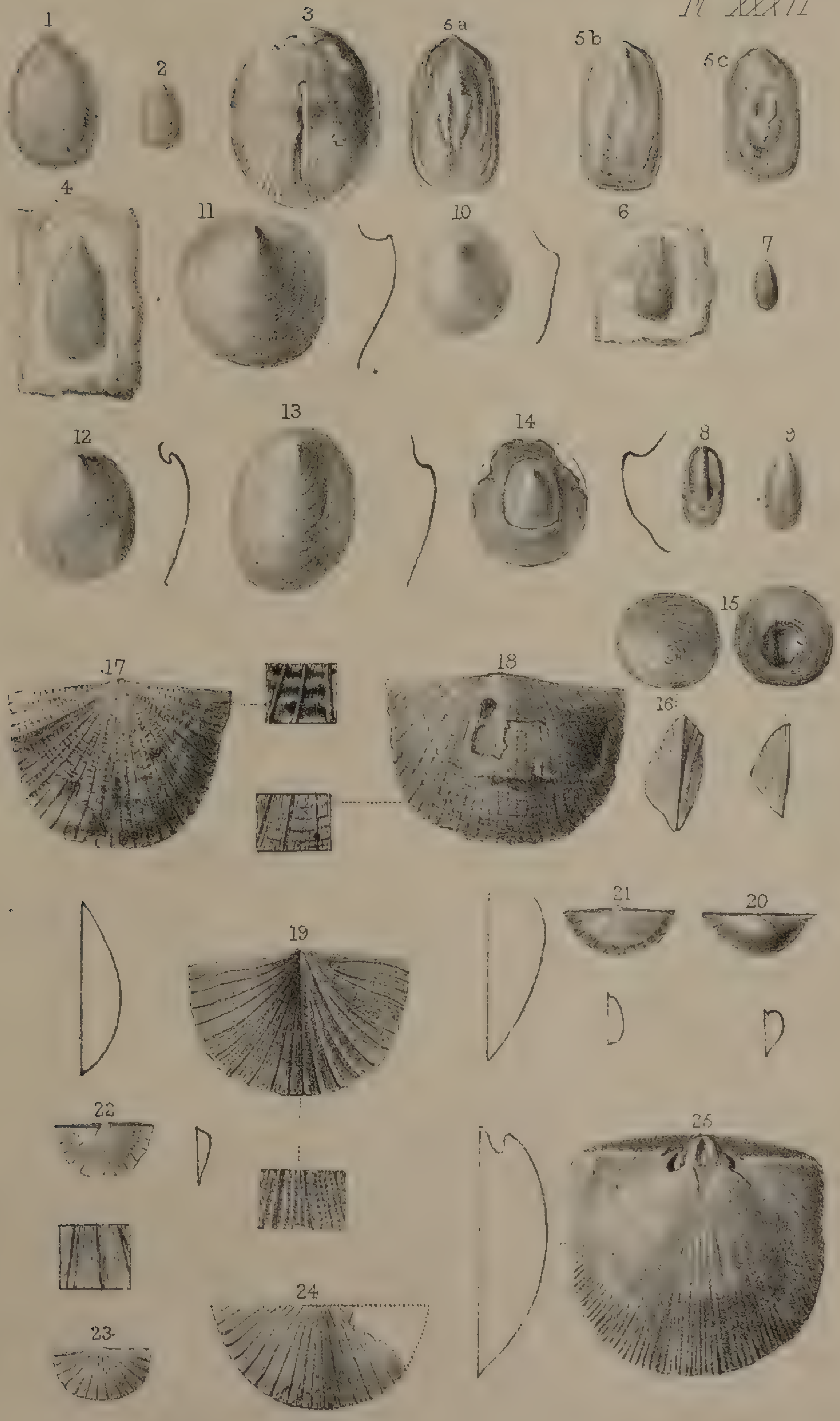
Pl XXXII



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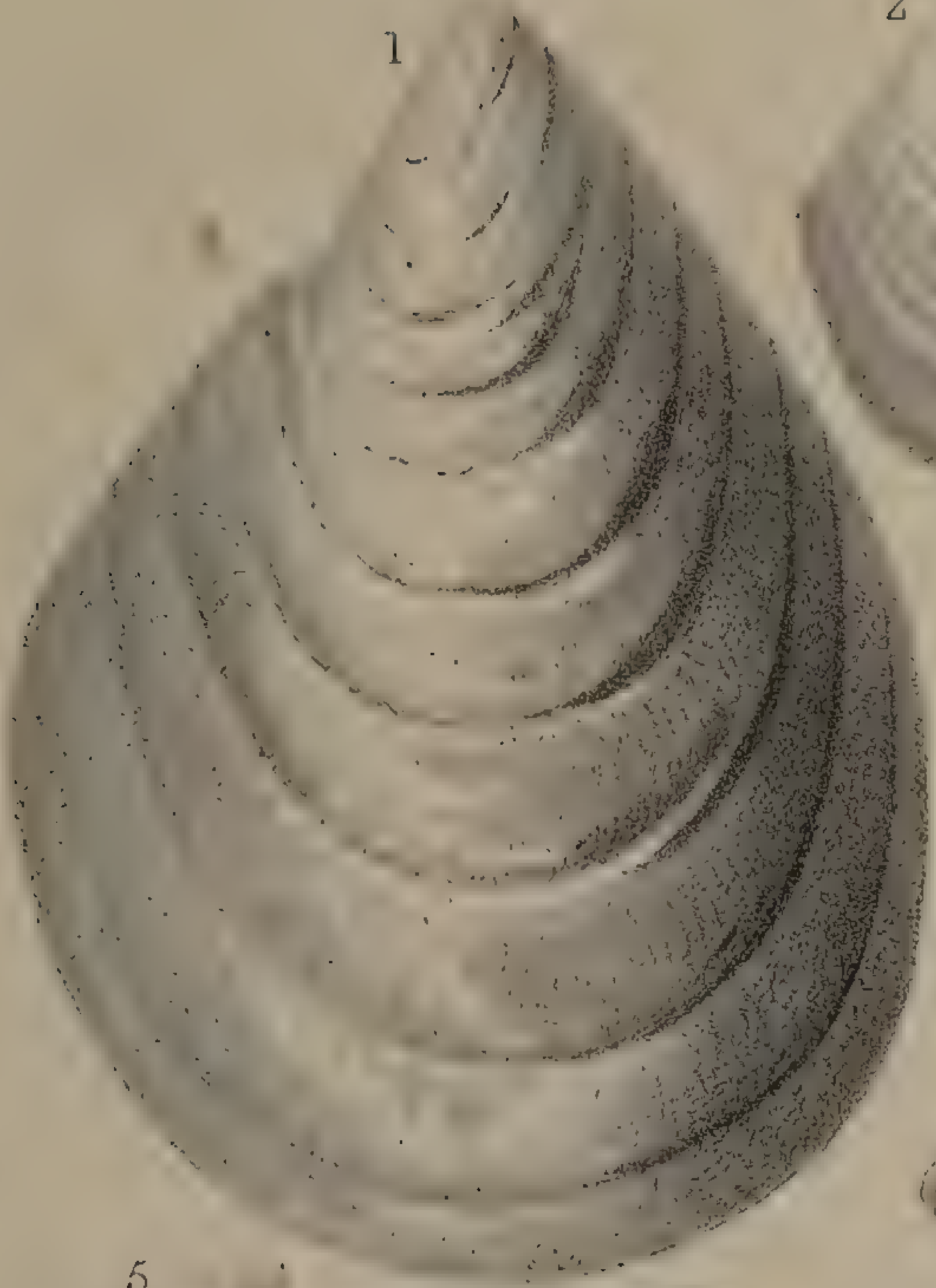
Pl. XXXIII

1



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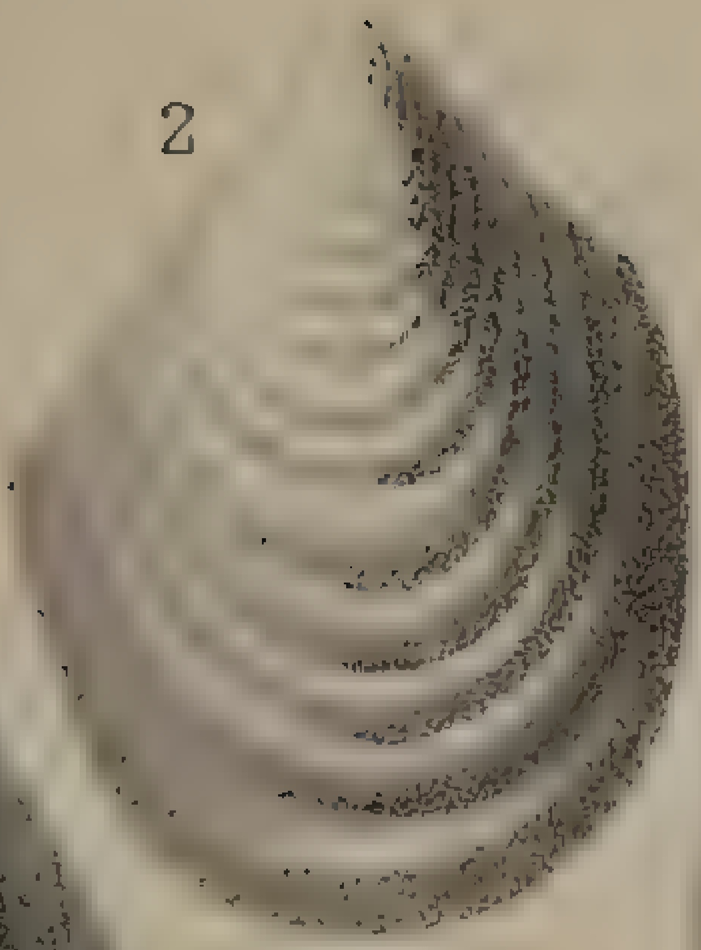

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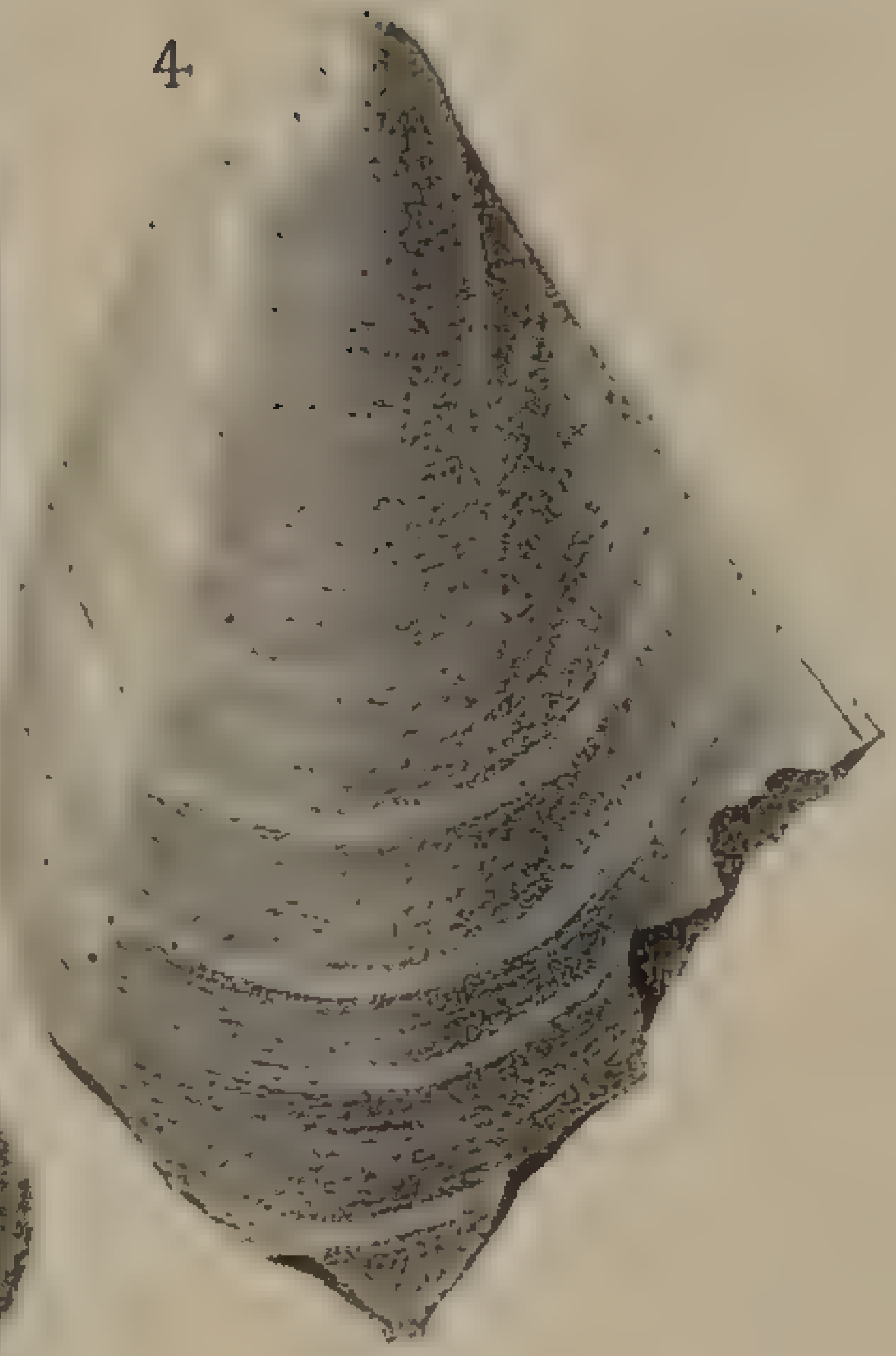

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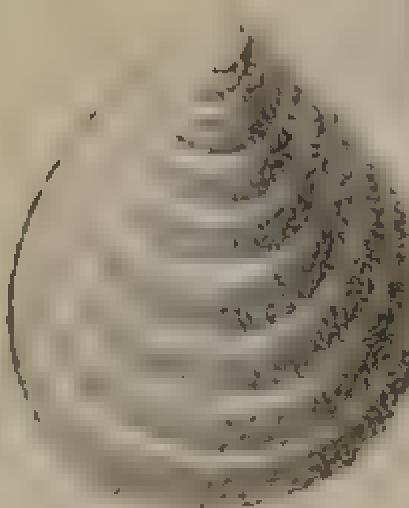

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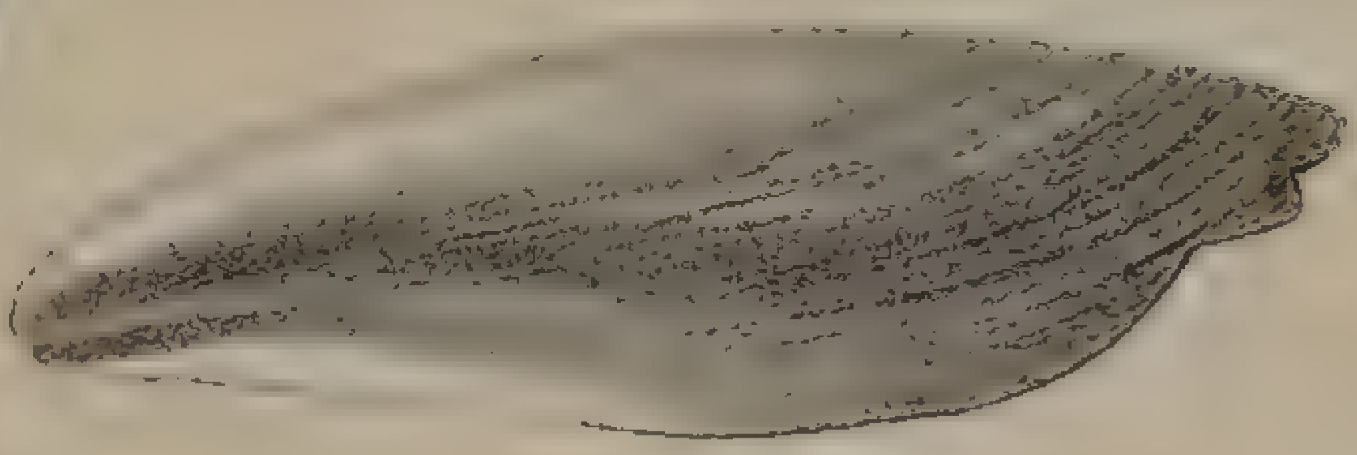

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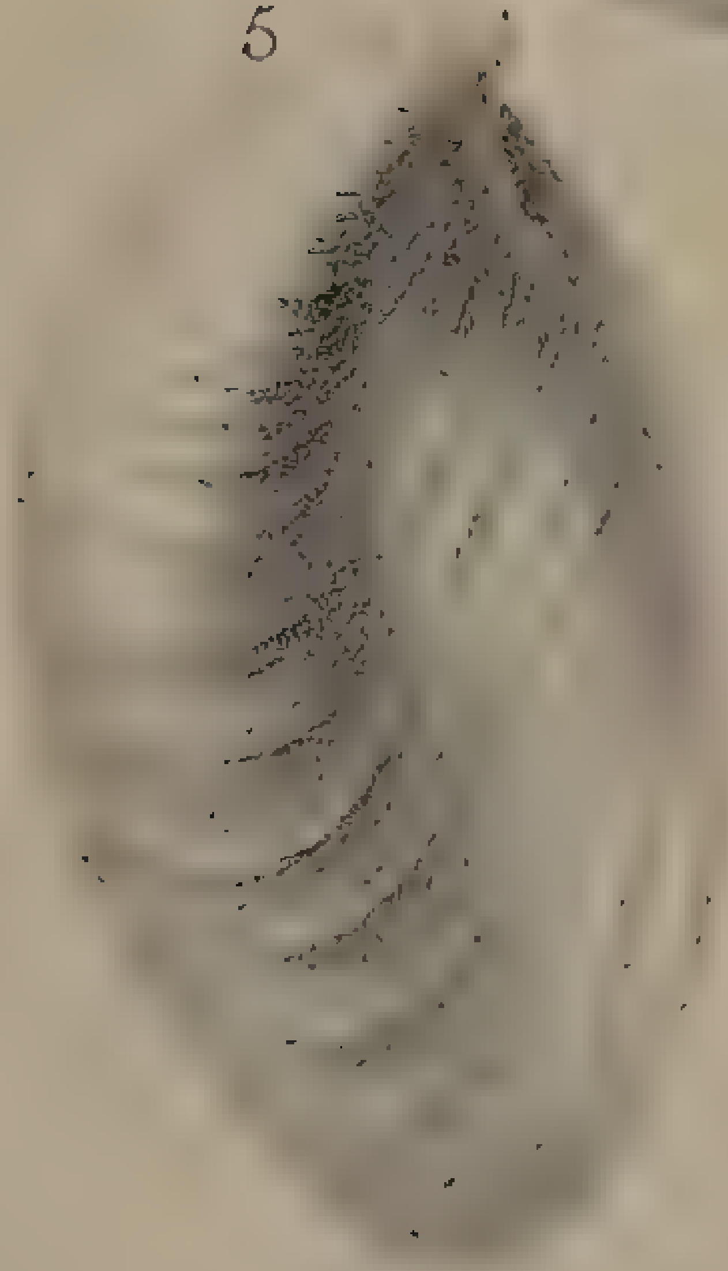

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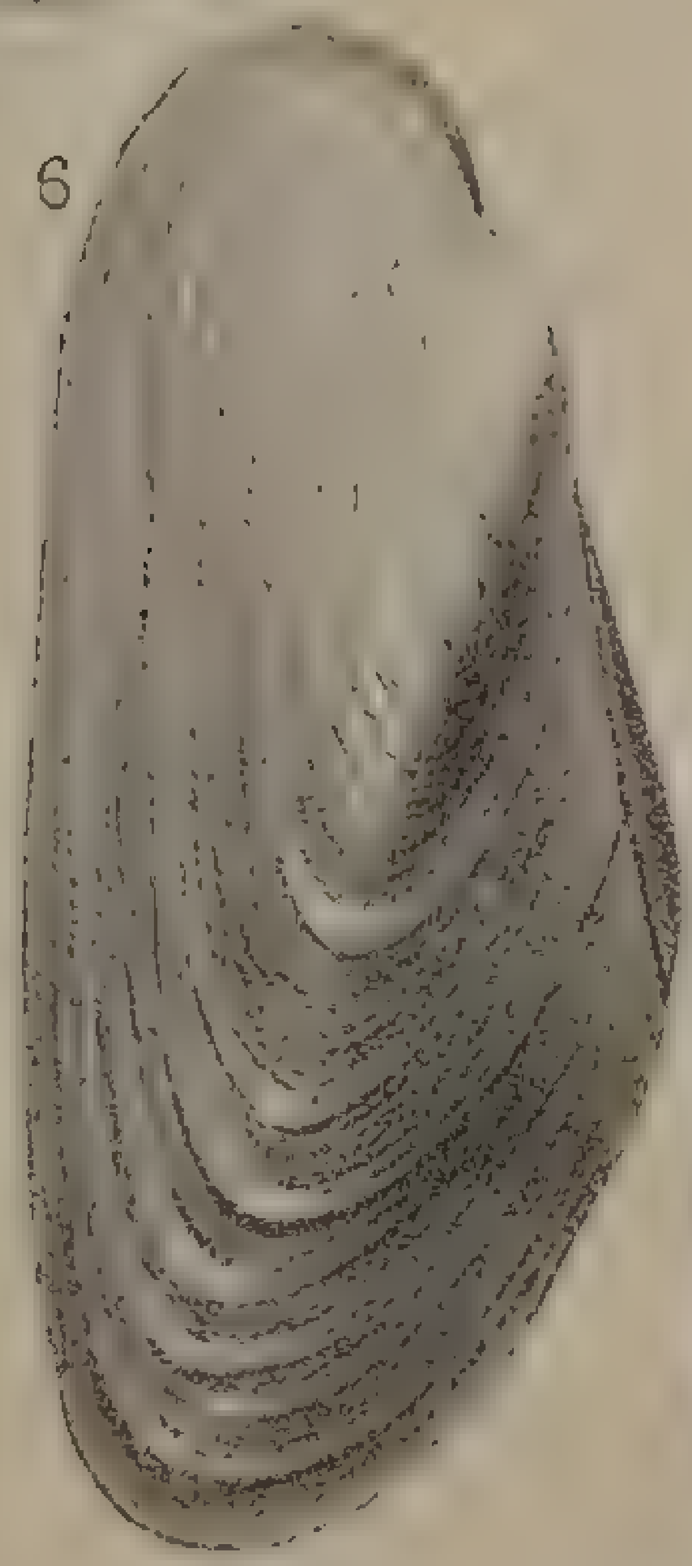

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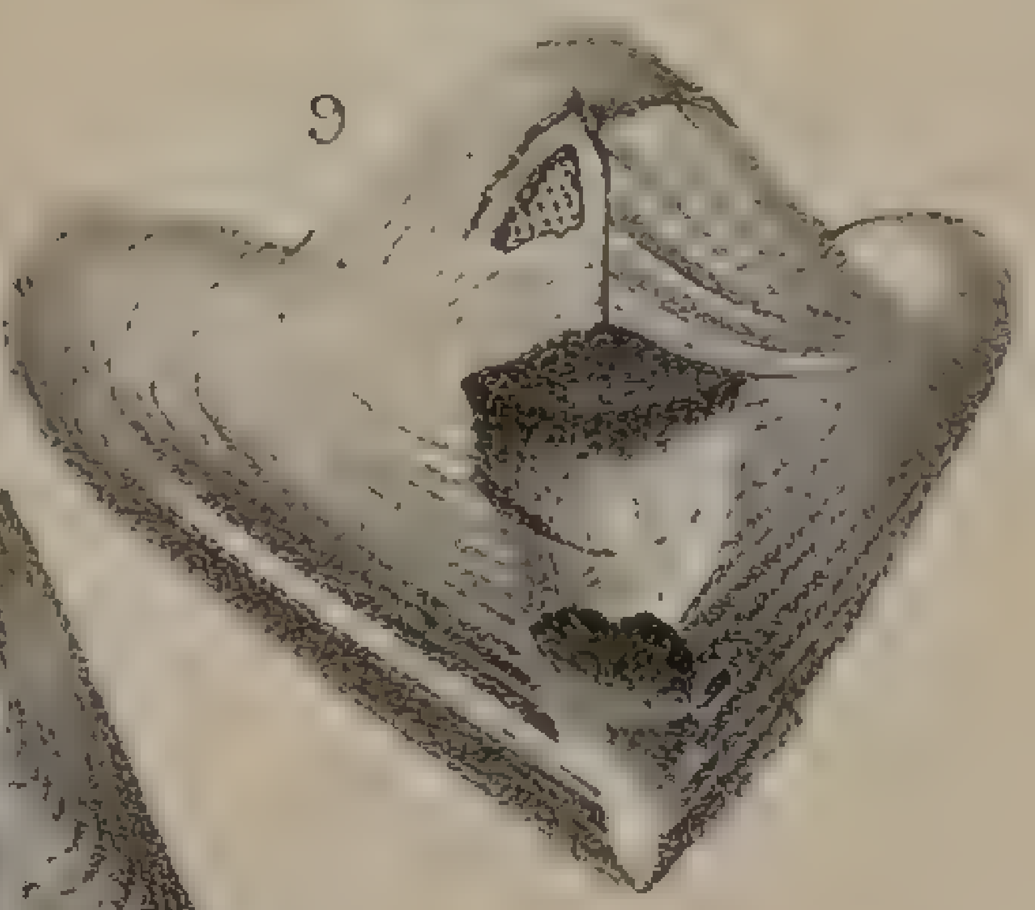

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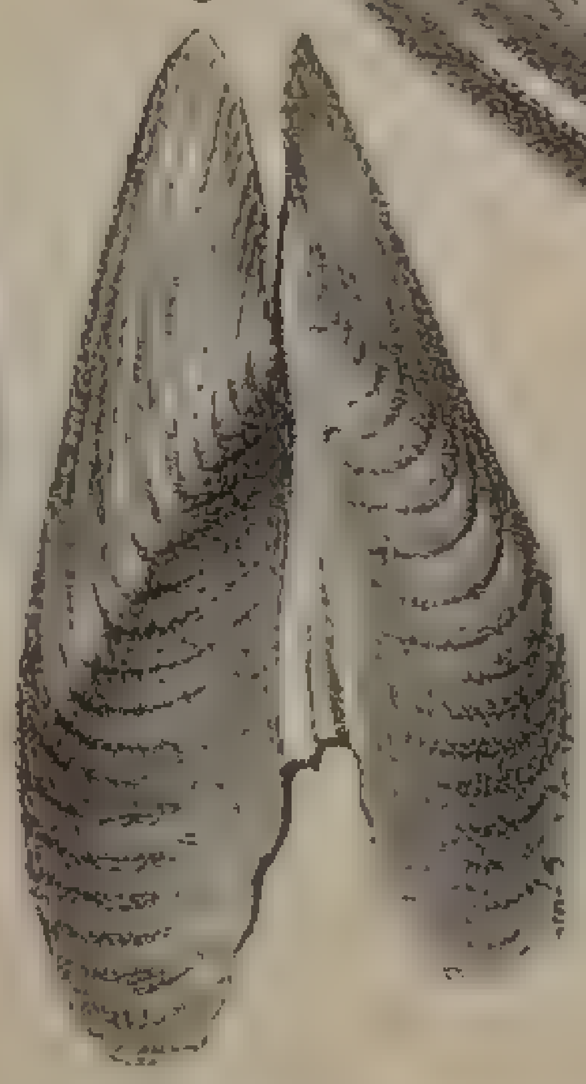

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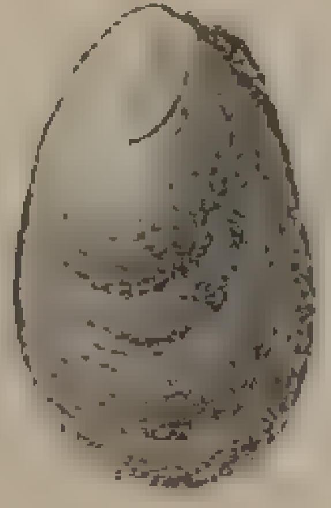

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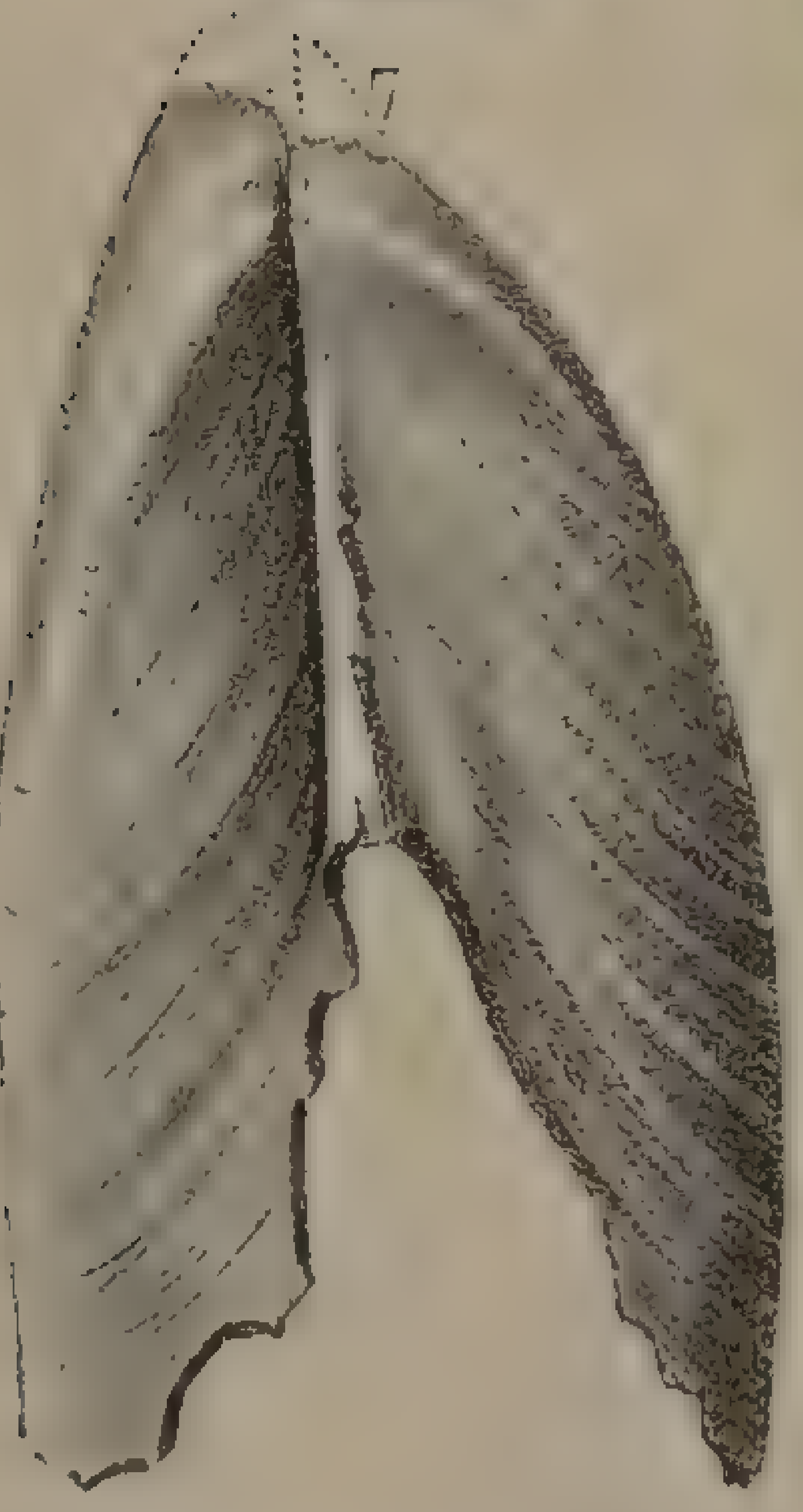

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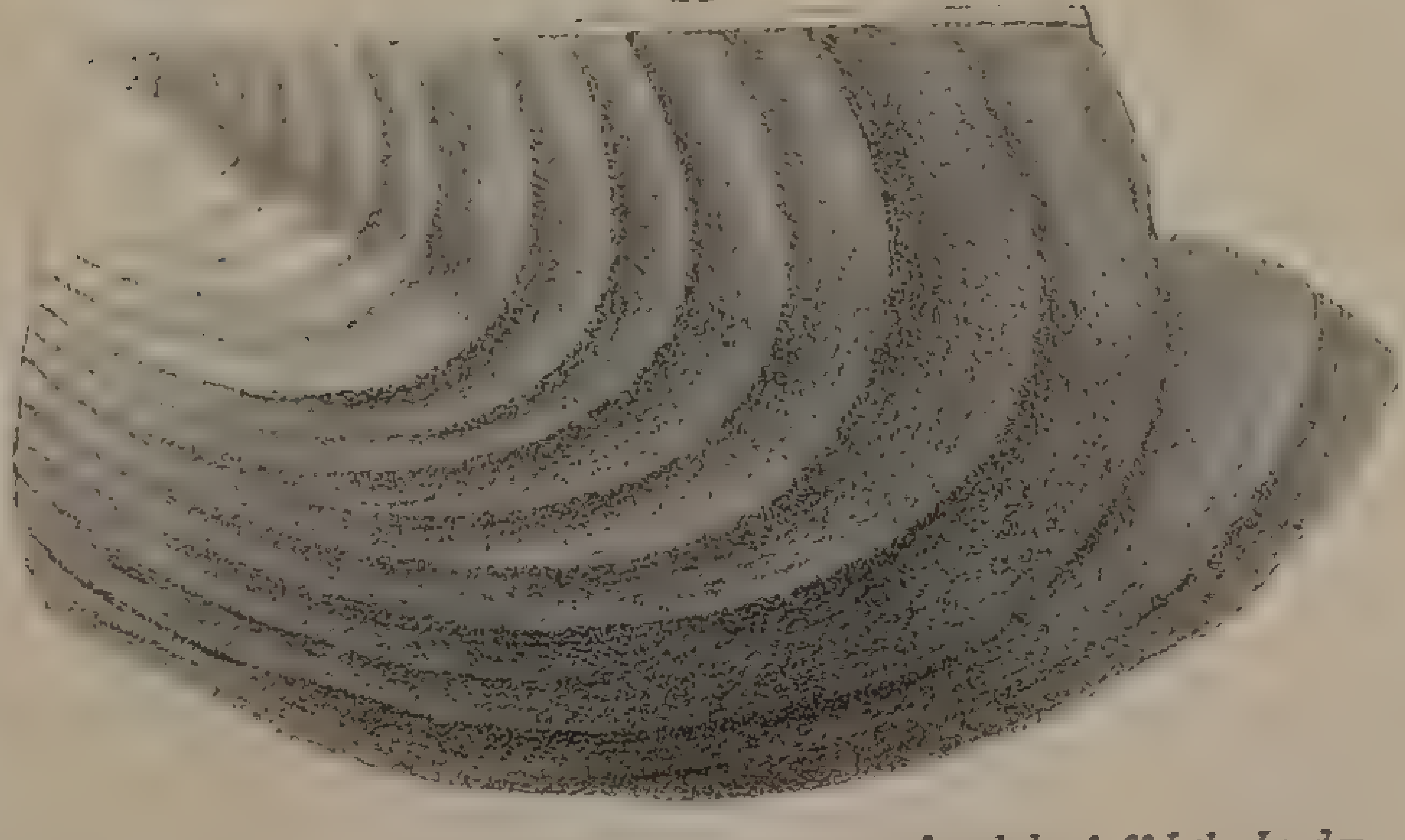
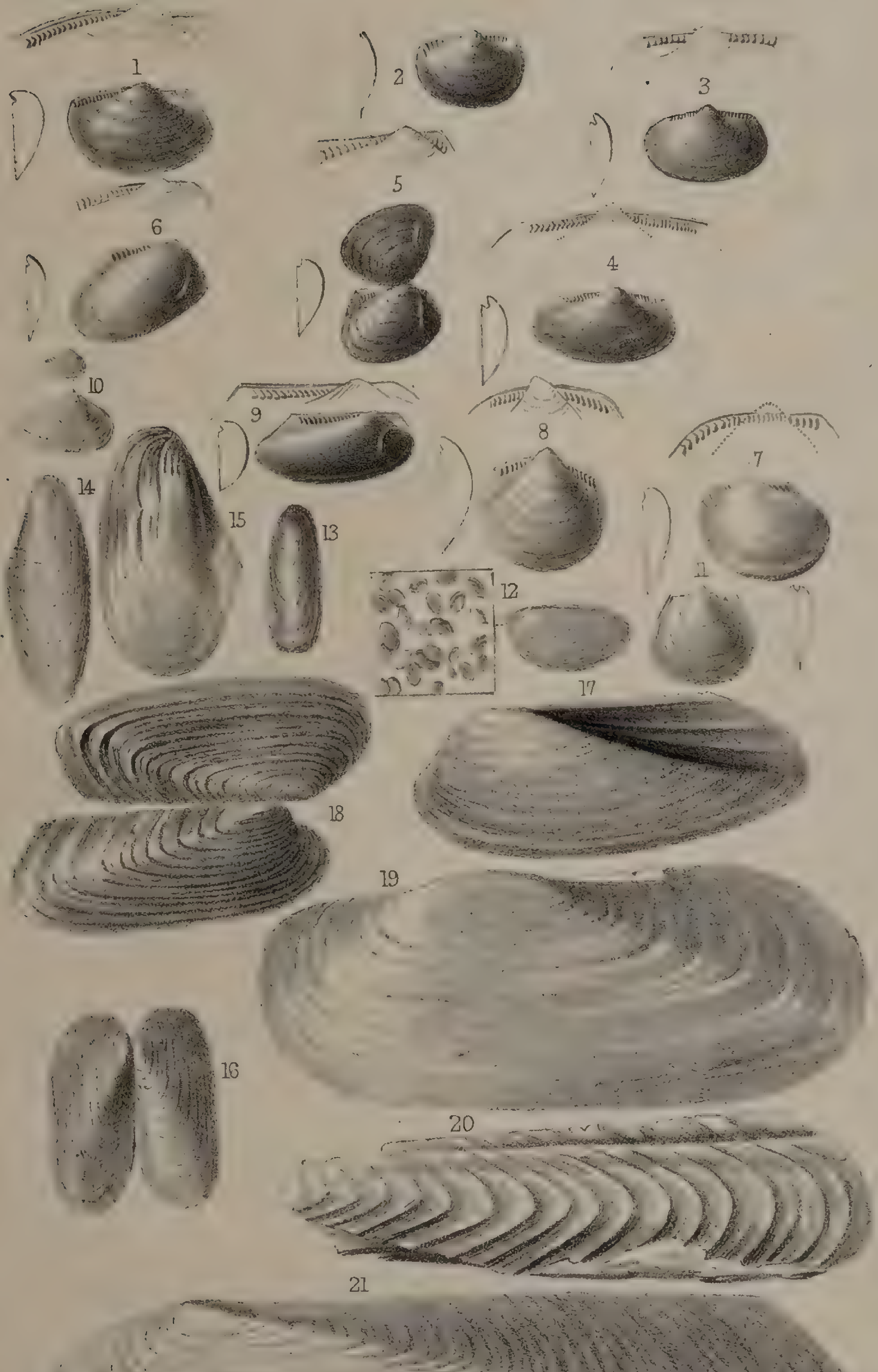


From Nature by Geo. Du Noyer

Standidge & Co Litho. London

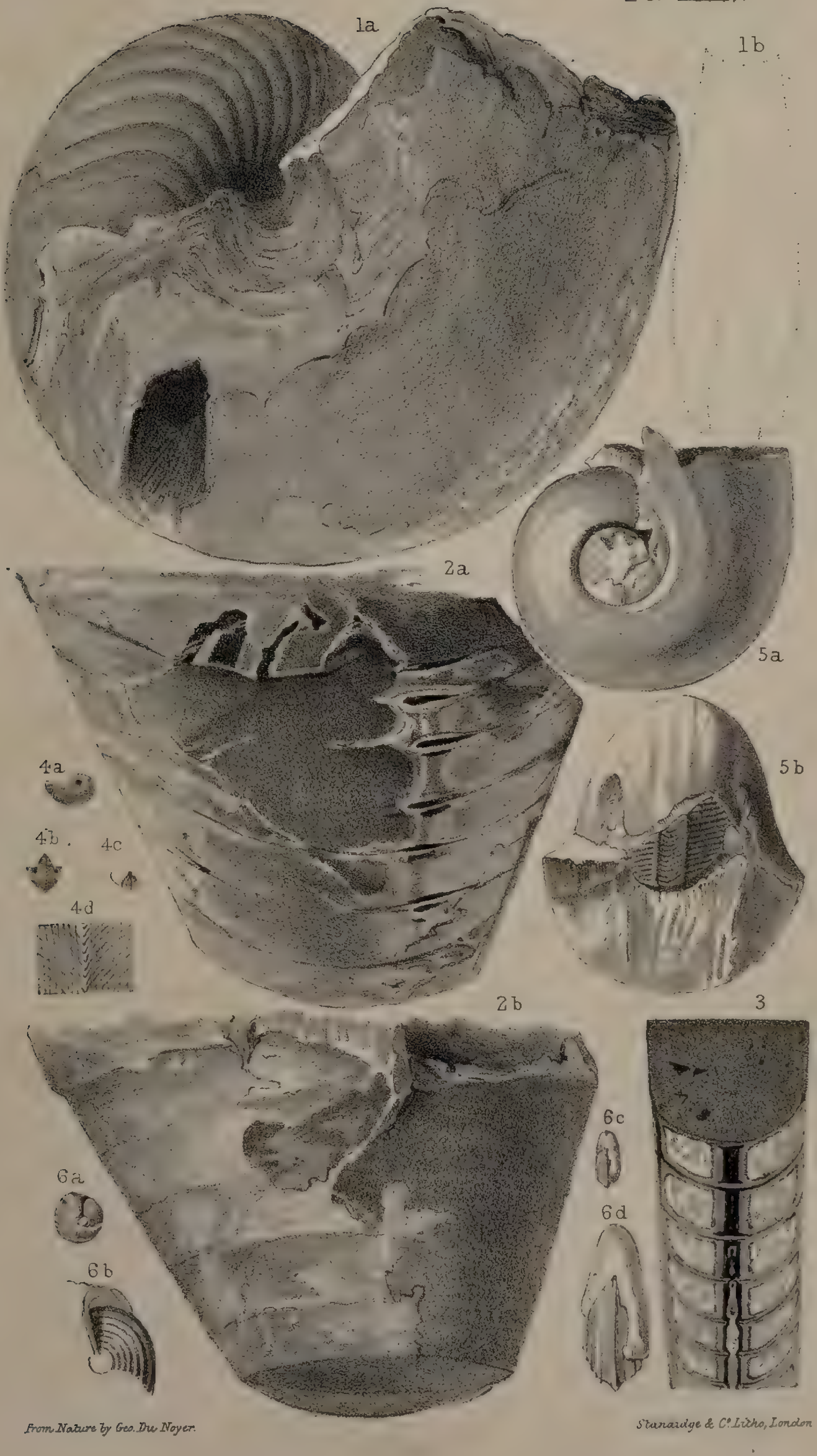
Pl. XXXIV.



From Nature by Geo Du Noyer.

Standidge & Co. Litho, London

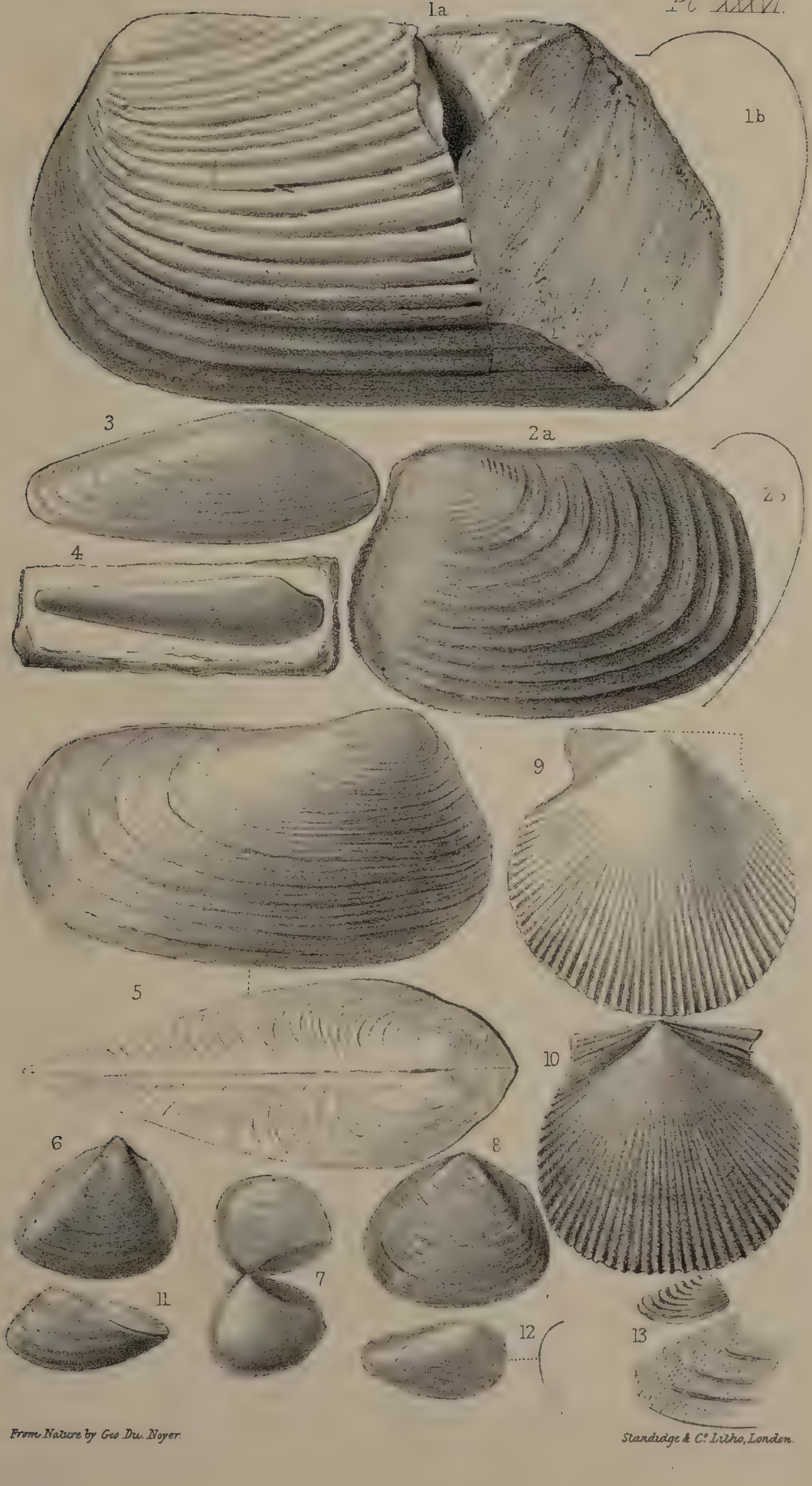
Pl. XXXV.



From Nature by Geo. Du Noyer.

Stanardge & Cº Litho, London

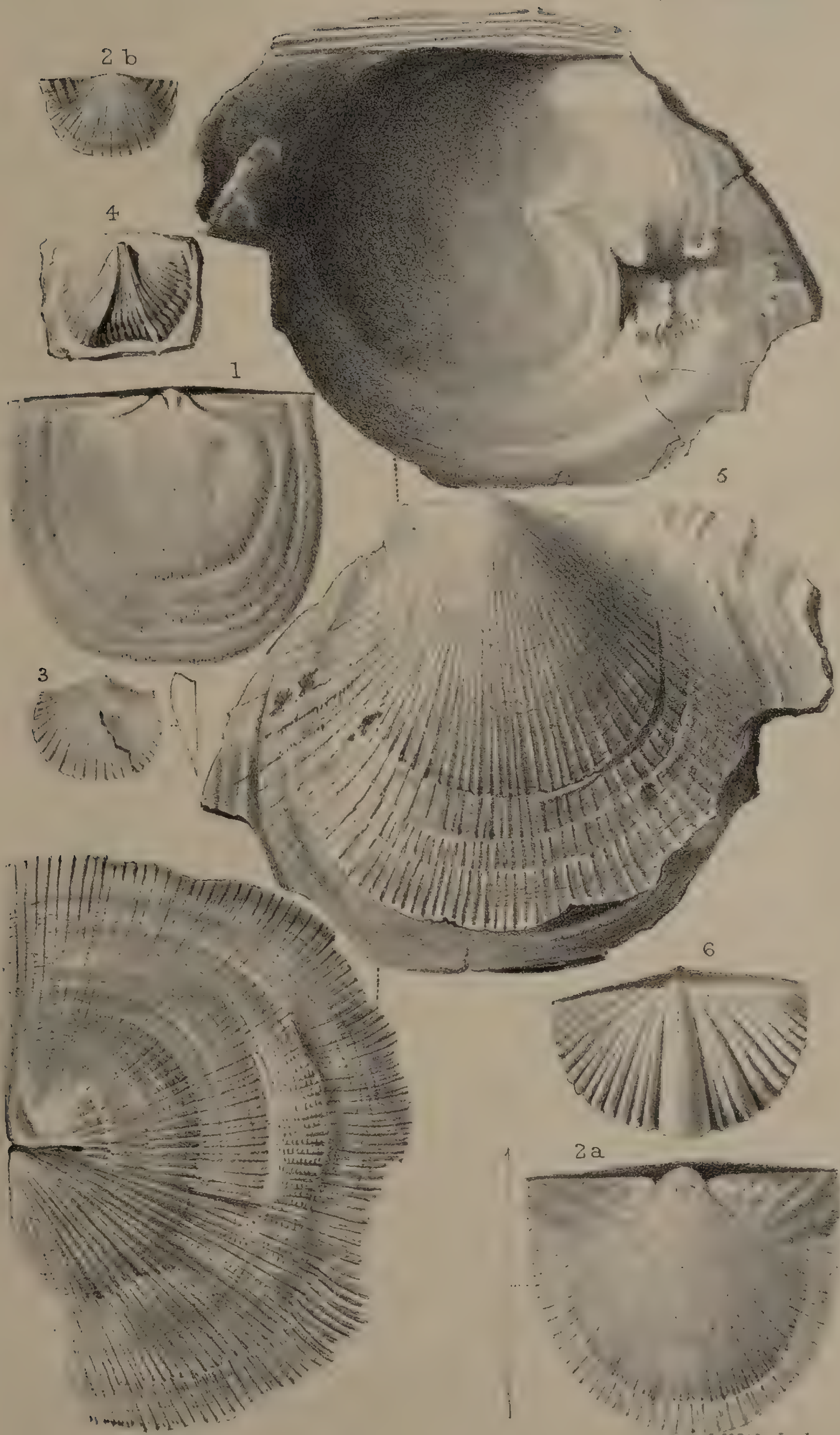
Pl XXXVI.



From Nature by Geo Du Noyer.

Standidge & Cº Litho, London.

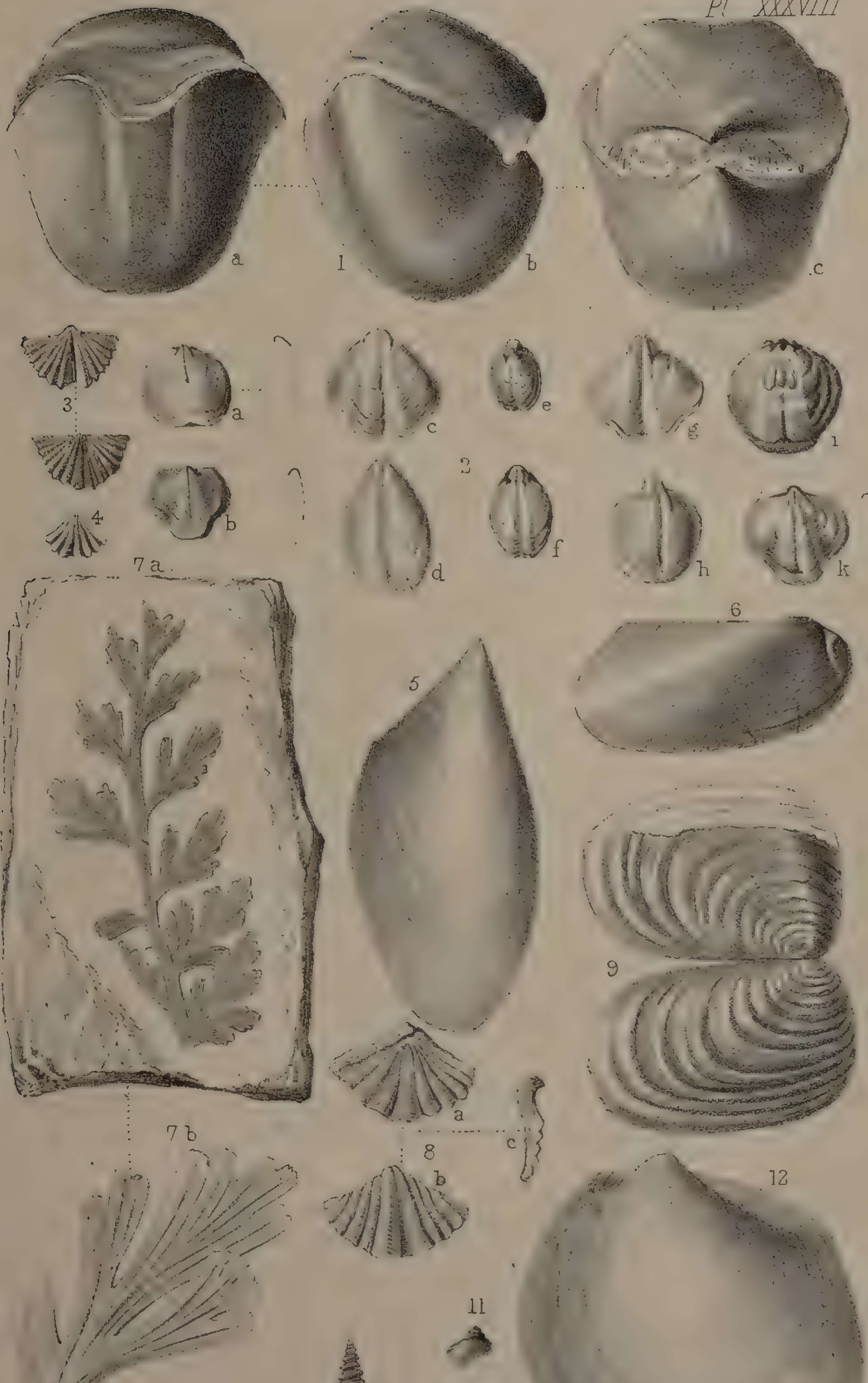
Pl. XXXVII



From Nature by Geo Du Noyer.

Standidge & Co Litho London.

Pl XXXVIII



From Nature by Geo. Du Noyer.

Standidge & Cº Litho London.

Fig. 1. Section from Lough Foyle to the Grey Rocks.

showing an apparent repetition of strata resulting from a compound slip.

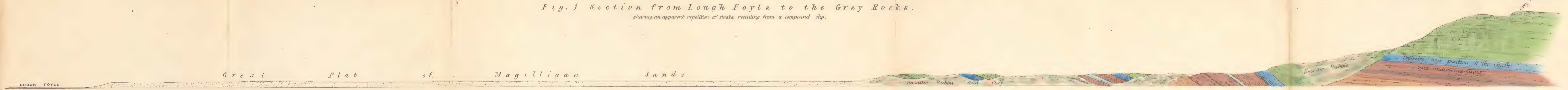

Grey Rocks. 912.
LOUGH FOYLE.
Great Flat of Magilligan Sands
Basaltic Rubble and Clay.
Basaltic Rubble
Probable true position of the Chalk
and underlying Strata.

Fig 2. Section of Benyevenagh Mountain

Shewing the great Slip.

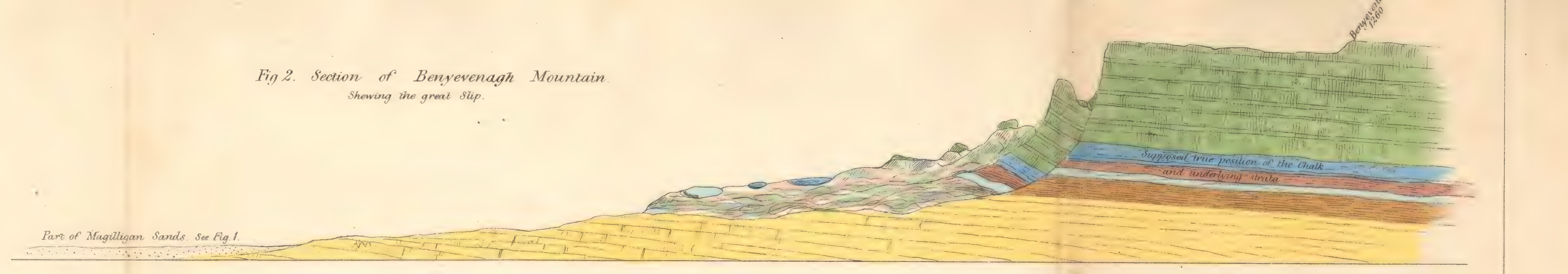

Benyevenagh 1260
Supposed true position of the Chalk
and underlying strata
Part of Magilligan Sands. See Fig 1.

Fig. 3. Section from Newtown Limavady to Stradreagh.

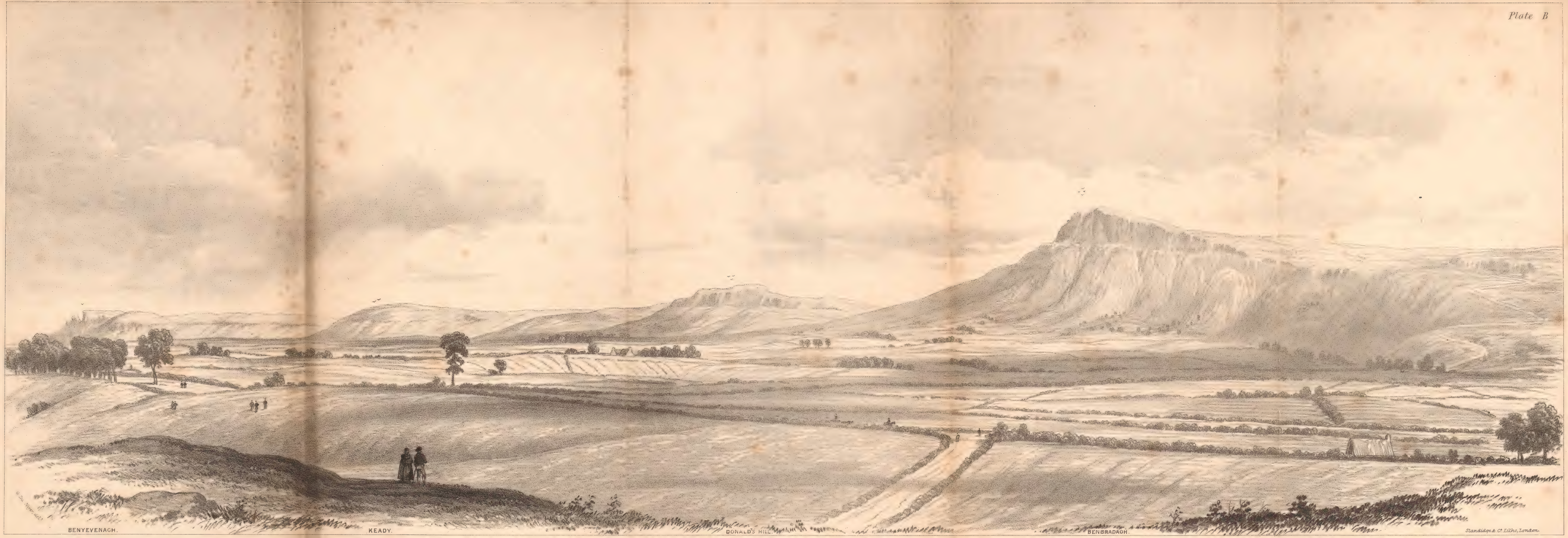
Fig. 4. Section across the Sandstone District in the Parishes of Dungiven and Bovevagh.

Glenconway Hill. 690
Very coarse thick-bedded Conglomerates.
Tertiary Clays
Irregularly developed beds of impure nodular Limestone with occasional beds of dark shales.
Oblique lamination not unfrequent in the Sandstones.
Tertiary Clays.
River Roe.
False bedding common
Road from Dungiven to Newtown L. Vady.
See Plate C. Fig 6.
Shales with Holoptychus scales, Plants, &c. in this portion of Section
Road from Dungiven to Garvagh.
Red and variegated Marls with thin-bedded soft Sandstones
Chalk & Greensand
Benbradagh 1531.
Mica Schist
Old Red System
Carboniferous System
New Red System
LINE OF SECTION
26°
18°
15°
13°

P. Oldham 1842.

Standidge & C^o Litho: London.

Plate B



VIEW TAKEN FROM THE PILLAR STONE, NEAR DUNGIVEN OLD CHURCH.

C^o Derry.

Plate C.

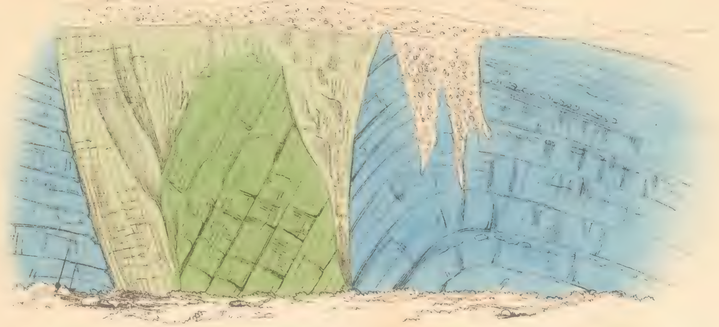


Fig. 1. Parish of Tamlaght. Sheet 49.

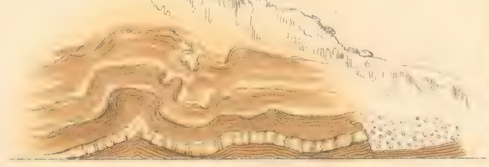


Fig. 2. P^h of Drumachose. Sheet 10.

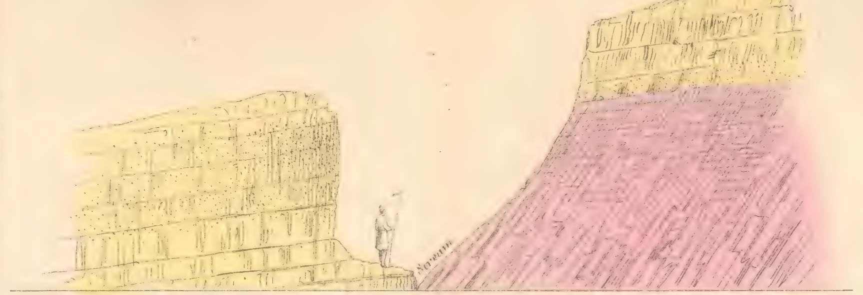


Fig. 3. On Coolagh River. Sheet 15.

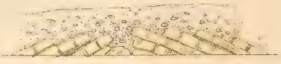


Fig. 4 On Ballykelly River Sheet 16.

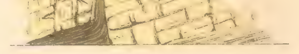


Fig. 5 P^h of Dungiven. Sheet 25.

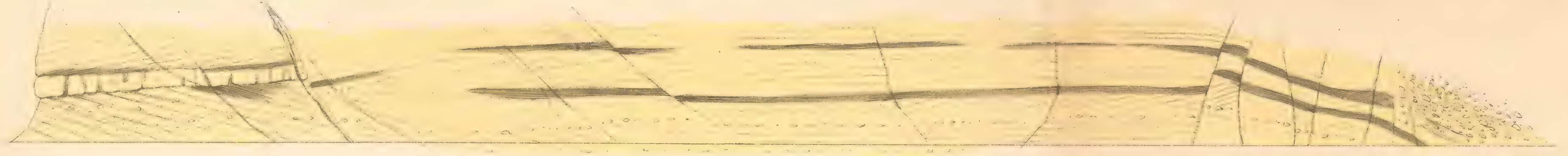


Fig 6 On banks of River Roe. Sheet 25.

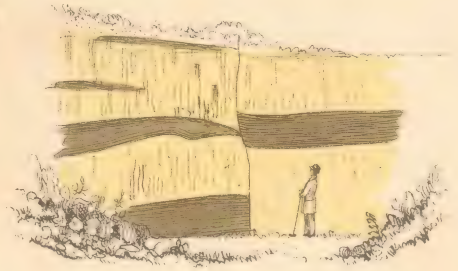


Fig. 7. In Altmover Glen. Sheet 24.

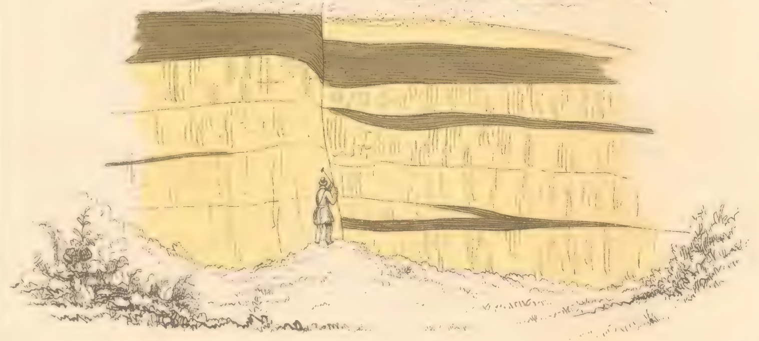


Fig. 8. In Altmover Glen. Sheet 24.

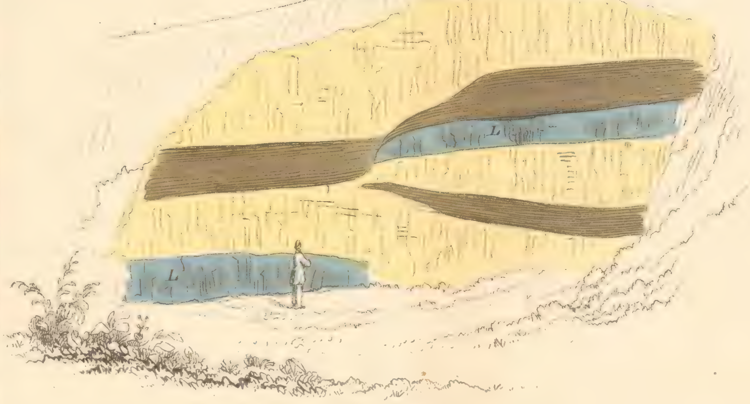


Fig. 9. In Altmover Glen. Sheet 24.

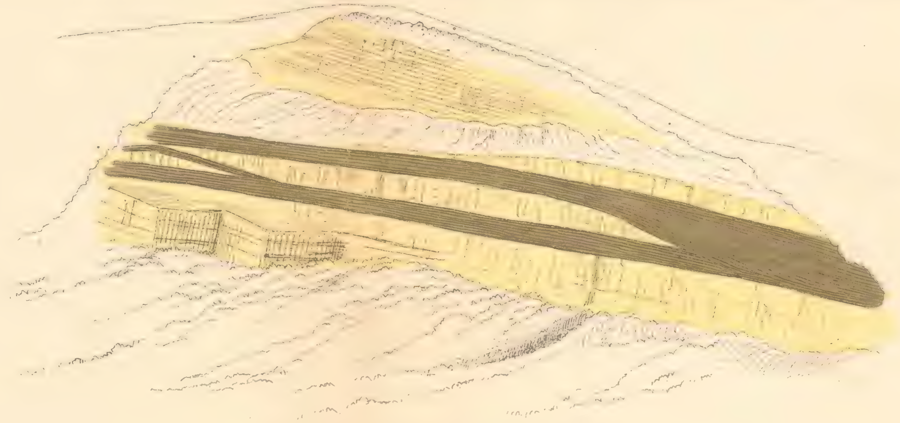


Fig. 10. In Altmover Glen. Sheet 24.

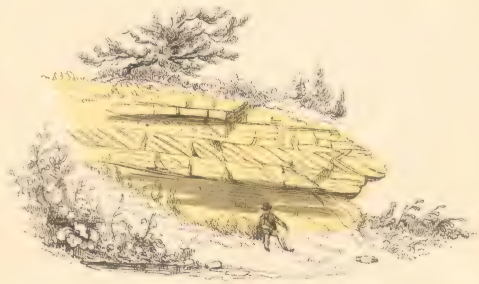


Fig. 11. Par^h of Ballynascreen. Sheet 35.

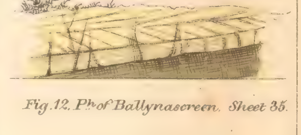


Fig. 12. P^h of Ballynascreen. Sheet 35.

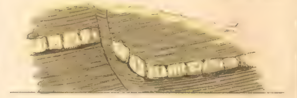


Fig. 13. Altagowan River Sheet 40.

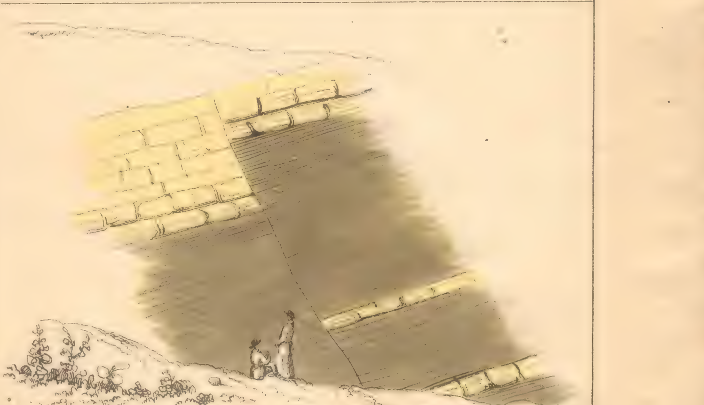


Fig. 14. Par^h of Ballynascreen. Sheet 35.

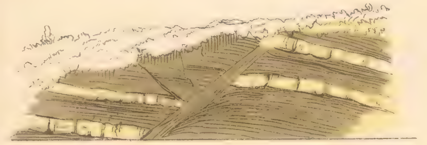


Fig. 15. On Altagowan River. Sheet 40.

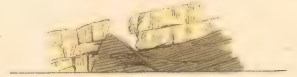


Fig. 17 P^h of Ballynascreen. Sheet 40.

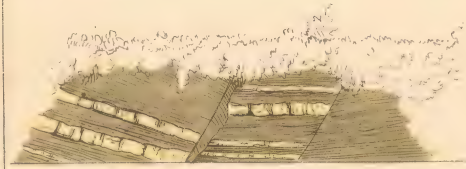


Fig. 16. On Altagowan River. Sheet 40

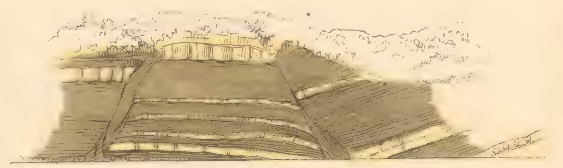


Fig. 18. On Altagowan* River. Sheet 40.

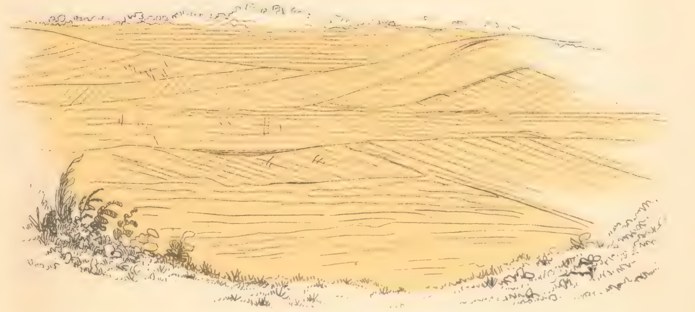


Fig. 19. Par^h of Artrea. Sheet 46.

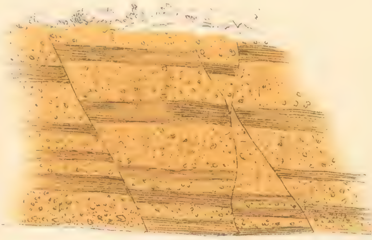


Fig. 20. P^h of Desertmartin Sheet 46.

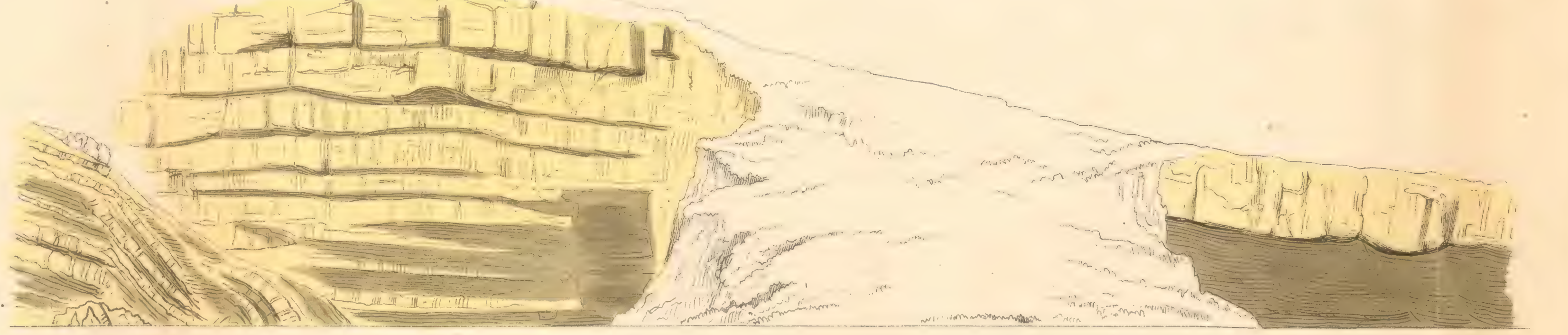


Fig. 21. On Altagowan River. Sheet 40.

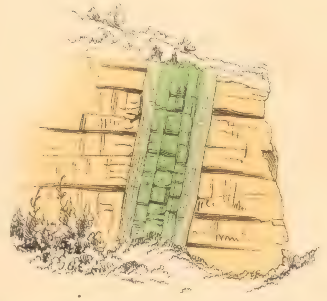


Fig. 22. P^h of Desertlyn. Sheet 46.

Scale for Figures 1 to 20. and Fig. 22.

feet 10 5 0 5 10 15 20 feet.

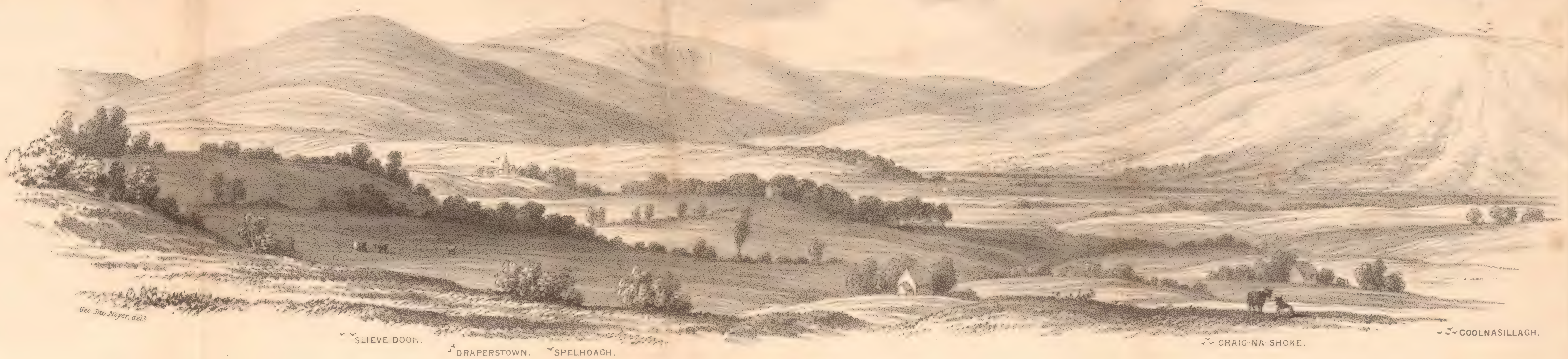
Scale for Fig. 21.

feet 10 5 0 10 20 30 feet.

T. Oldham 1842

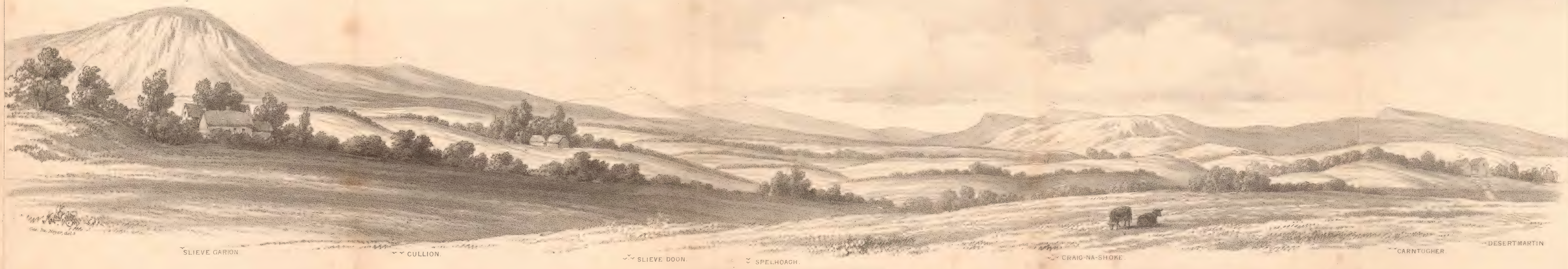
Standidge & C^o Litho. London.

Plate D


Geo. Du Noyer, delt.
SLIEVE DOON.
DRAPERSTOWN.
SPELHOAGH.
CRAIG-NA-SHOKE.
COOLNASILLAGH.

VALE OF BALLYNASCREEN.

VIEW TAKEN FROM ABOUT ONE MILE EAST OF DRAPERSTOWN.



VALE OF BALLYNASCREEN,

FROM THE NEIGHBOURHOOD OF DESERTMARTIN.

Standidge & Co. Litho, London.

Plate E.

Fig. 1. Section through Corick Hill. Parish of Dungiven.

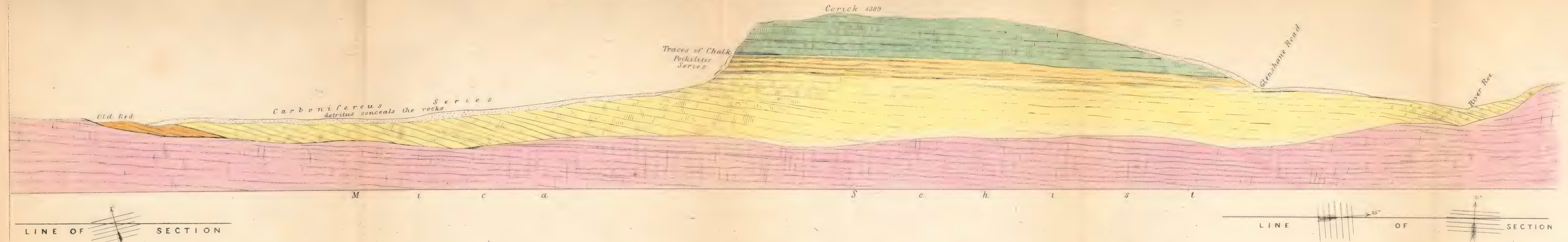


Fig. 2. Section through Craig-na-shoke Mountain.

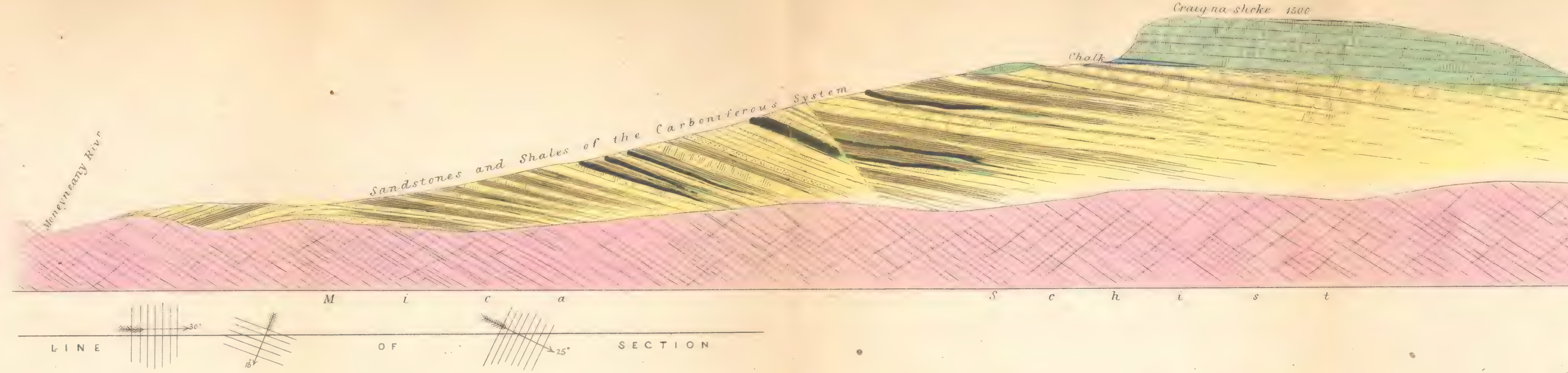


Fig. 3. Section shewing the relative position of the detached Basaltic cap of Slieve Gallion Carn.

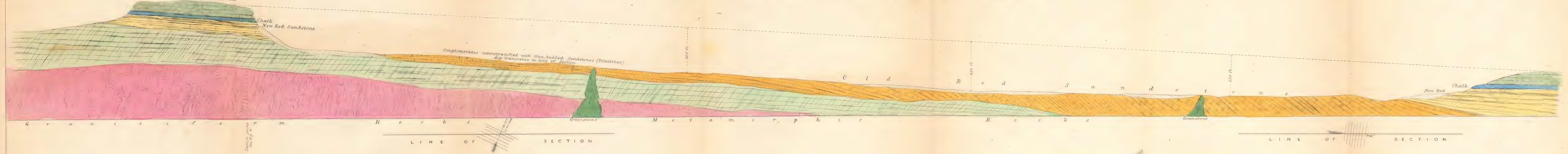


Fig. 4. Section from Slieve Gallion Carn joining Fig. 5.

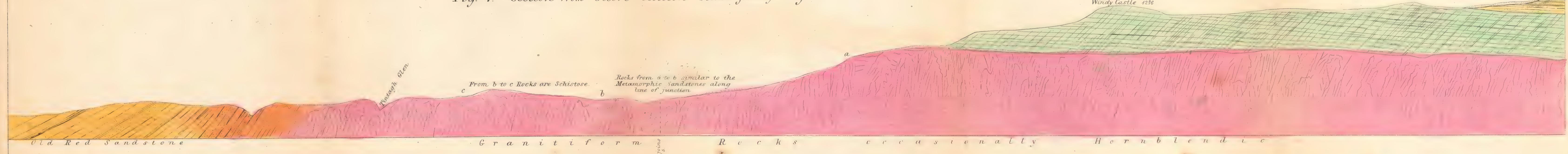

Windy Castle 1236
New Red S.ne
Chalk
Tintagh Glen
a
b
c
From b to c Rocks are Schistose
Rocks from a to b similar to the Metamorphic Sandstones along line of junction
Old Red Sandstone
Granitiform Rocks occasionally Hornblendic
Section joins See Fig. 5
Section joins See Fig. 4

Fig. 5. Section through Slieve Gallion joining Fig. 4.

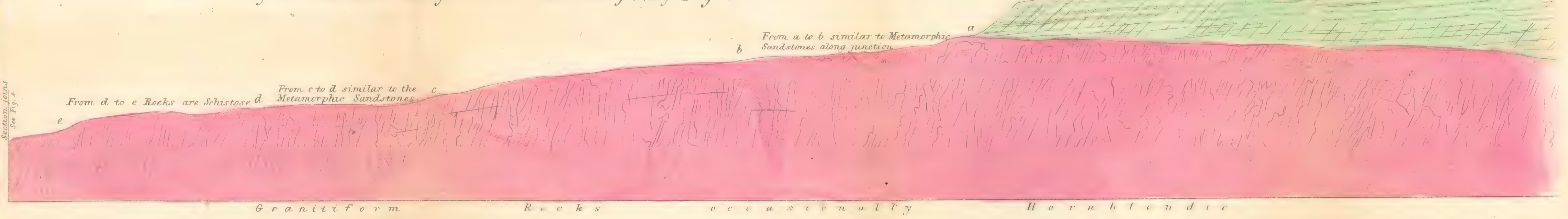

Slieve Gallion 1730
a
b
c
d
e
From a to b similar to Metamorphic Sandstones along junction
From c to d similar to the Metamorphic Sandstones
From d to e Rocks are Schistose
Granitiform Rocks occasionally Hornblendic

Fig. 6. Section on the Moyola River. Parish of Ballynascreen.

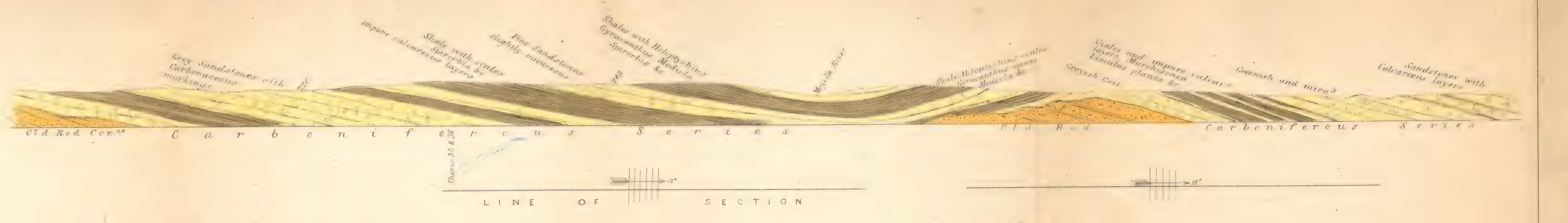

Grey Sandstones with carbonaceous markings
Impure calcareous layers
Shale with scales Spirorbis &c
Fine Sandstones slightly micaceous
Shales with Holoptychius Gyracanthus Modiola Spirorbis &c
Moyola River
Greyish Grit
Shales and impure calcareous layers, Murchisonia Limulus plants &c
Greenish and micaceous
Sandstones with Calcareous layers
Old Red Cong.te
Carboniferous Series
Old Red
Carboniferous Series
Sheets 35 & 36
LINE OF SECTION
12°
18°

Fig. 7. Section shewing the position of the Limestone at Cullion.

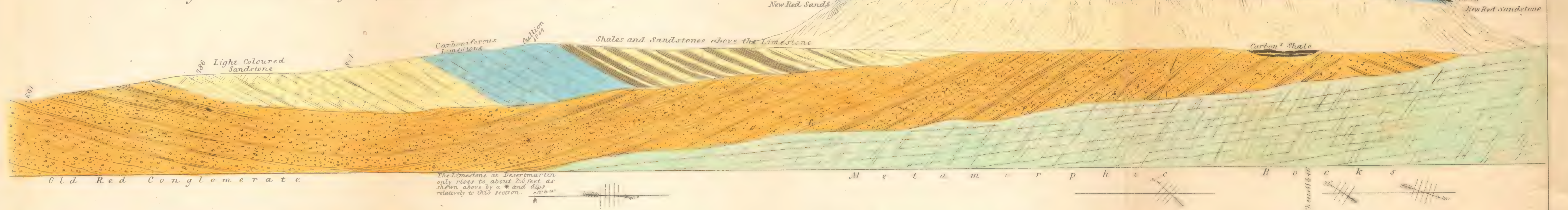


Fig. 8. Section on the White Water. Parish of Ballynascreen.

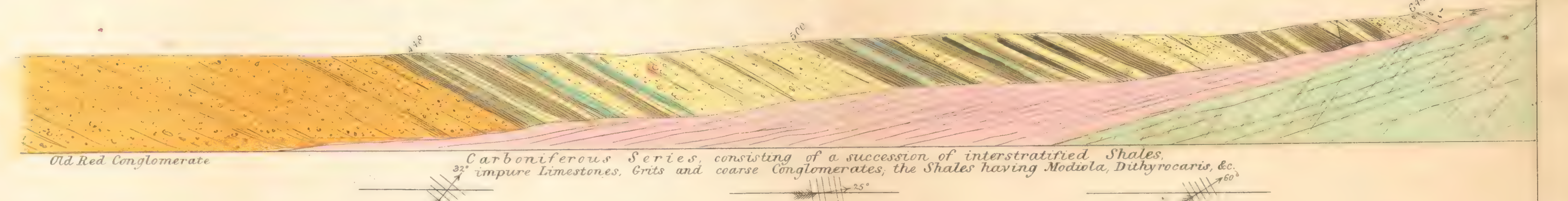
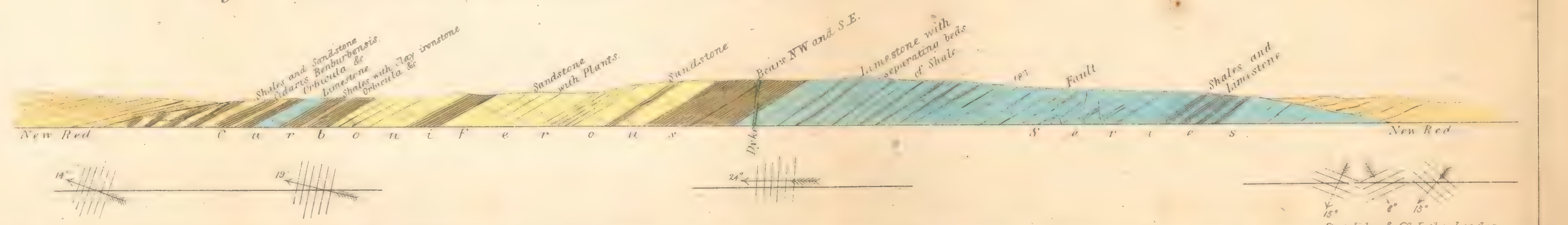

448
500
644
Old Red Conglomerate
Carboniferous Series, consisting of a succession of interstratified Shales, impure Limestones, Grits and coarse Conglomerates, the Shales having Modiola, Dithyrocaris, &c.
32°
25°
60°

Fig. 9. Section shewing the succession of the strata at Benburb.



G. Oldham

Scale, Six inches to one Mile.

Standidge & C.o Litho. London.

Fig. 1. General Section from Lough Foyle in the North, to Lough Neagh in the South.

Fig. 2 General Section continued from Fig. 1

Fig. 3. General Section continued from Fig. 2.

Fig. 4. General Section continued from Fig. 3.

J. Oldham. 1842.

Standidge & C^o Litho. London.

Plate G.

Fig. 1. Section shewing an outlying portion of Basalt and Chalk near Stewartstown.

Bearing of Section N. 52. E.

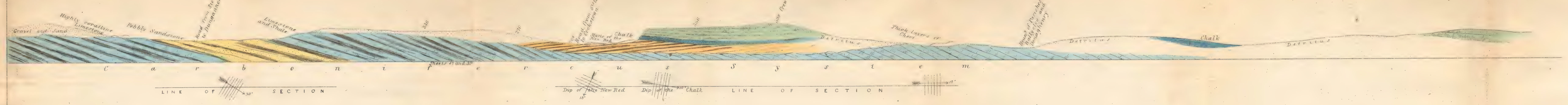


Fig. 2. Section shewing the position of the Silurian Rocks near Pomeroy.

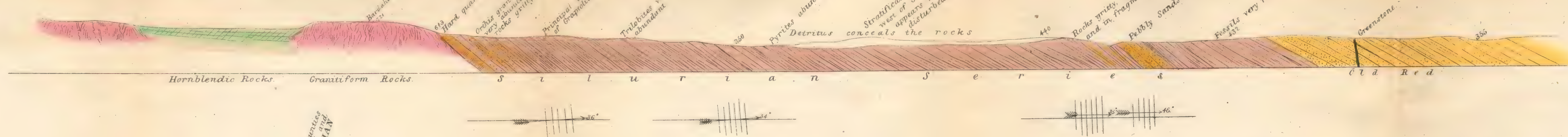

Hornblendic Rocks
Granitiform Rocks
Hard quartzose bed
Orthis grandis &c very abundant rocks gritty
Principal deposit of Graptolites
Trilobites very abundant
Pyrites abundant
Detritus conceals the rocks
Stratification west of Section appears much disturbed
Rocks gritty, fossils rare and in fragments
Pebbly Sandstone
Fossils very rare
Greenstone
Silurian Series
Old Red

Fig. 4. Section in the neighbourhood of Clogher.

Bearing of Section S. 14. E.

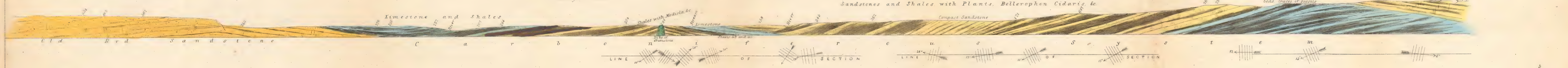
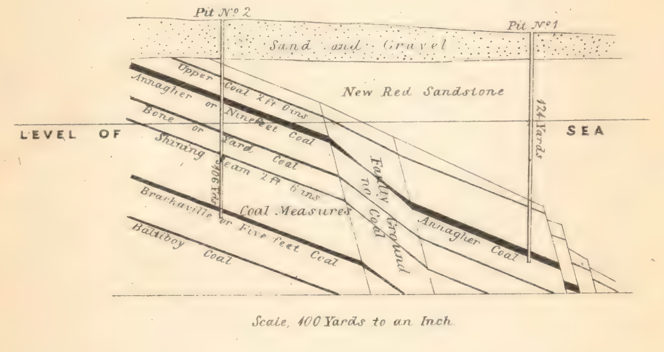

Sandstones and Shales with Plants, Bellerophon Cidaris, &c.
Limestone and Shales
Shales with Modiola &c
Limestone
Dyke of Greenstone
Sheets 58 and 65
Compact Sandstone
Hard clayey and calcareous beds, traces of Fossils
Sandstone and Shales Cidaris &c
Boundy of Counties TYRONE and MONAGHAN
Old Red Sandstone
Carboniferous System
LINE OF SECTION
LINE OF SECTION

Fig. 3. Section of Annagher Colliery, near Coal Island. Co Tyrone.

Furnished by Richard Griffith, Esqre

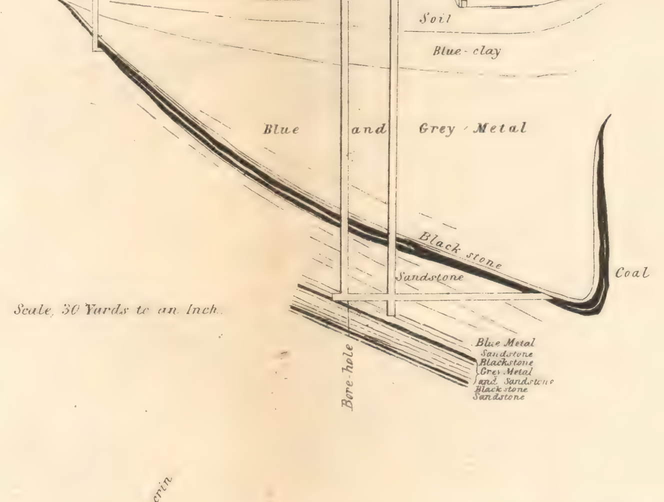
(See Plan, Plate H)



Scale, 400 Yards to an Inch.

Fig. 3*. Section of the Lewin Pits, Drumglass Colliery

on line A. B. (See Plan, Plate H.)



Scale, 30 Yards to an Inch.

Fig. 5. Section in the neighbourhood of Fivemile-town.

Bearing of Section S. 40. E

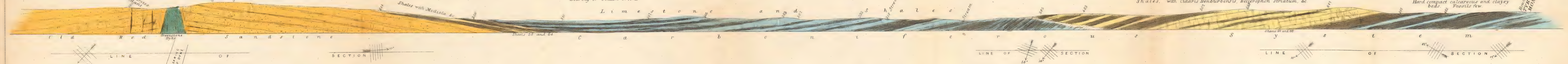

Sulphate of Barytes very abundant
Greenstone Dyke
Shales with Modiola &c
Limestone and Shales
Stream
Sandstones with Plants, hard calcareous layers and Shales, with Cidaris Benburbensis, Bellerophon striatum, &c.
Hard compact calcareous and clayey beds. Fossils few.
Boundy of Counties TYRONE and MONAGHAN
Sheets 58 and 64
Sheets 64 and 68
Old Red Sandstone
Carboniferous System
LINE OF SECTION
BEARING OF DYKE
LINE OF SECTION
LINE OF SECTION

Fig. 6. Section from near Lough Derg in the County of Donegal to near Maguires-Bridge in the County of Fermanagh.

Bearing of Section S. 31. E.

Mica Schist
Old Red
First Limestone Chert Sandstones and Shales
Limestone and Shale
Boundy of Counties DONEGAL and FERMANAGH.
Sandstone shaly and calcareous in the lower beds fossils
Shales with Modiola &c sectional position doubtful
Occasional beds or laminar Sandstone
Thin seam of Coal
Grits abounding in fossils. Pecten &c
Shales with Modiola Fish scales and spines &c much disturbed.
Ranagh River
Dyke
Grits very fossiliferous Pecten Odonisdo
Probable continuation of fault by which the Limestone has been thrown up.
Limestone and Shale very coralline
Kesh River
Fossiliferous Grits
Sheets 5 and 11
Boundy of Parishes of Magheraculmoney and Derryvullan
Monaghan
Drumcrin
Sheets 10 and 11
Carboniferous System
Old Red Sandstone
Dip of the Schist
Old Red
LINE OF SECTION
LINE OF SECTION

Fig. 7. Section continued from Fig. 6.

J. Oldham 1842

SCALE FOR FIG. 1.
6 Inches to one Statute Mile

SCALE FOR FIGs 2. 4. 5. 6. 7.
3 Inches to one Statute Mile

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Plate H

• Bore-hole sunk 102 Fathoms to try for another seam of Coal below that worked. The borings were in Limestone and hard Limestone Shale, below the Coal Measures

PLAN
OF THE HIBERNIAN MINING COMPANY'S WORKINGS,
in
DRUMGLASS COAL FIELD,
COUNTY OF TYRONE.

N. B. The shaded portions of the Plan denote those parts
from which the Coal has been entirely extracted.
The Arrows shew the dip.

Compiled and reduced from the original Plans:
The underground surveys by Messrs R. Heckles and E. Sinclair.
The workings in the Lewin Pits are given up to October 1842.

T. Oldham

Standidge & Cº Litho, London.

Plate I.

Fig. 1. Ph. of Banagher. Sheet 30.

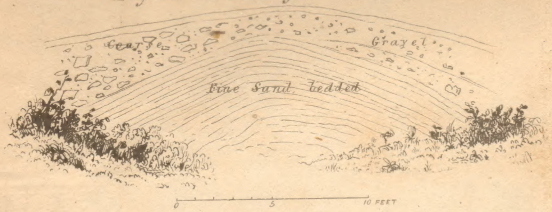


Fig. 2. Ph. of Desertoghill. Sheet 18.

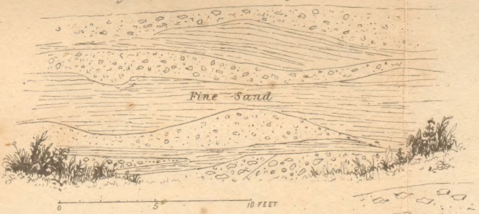
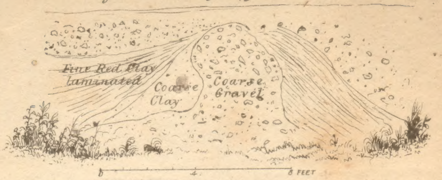


Fig. 3. Ph. of Agivey. Sheet 12.



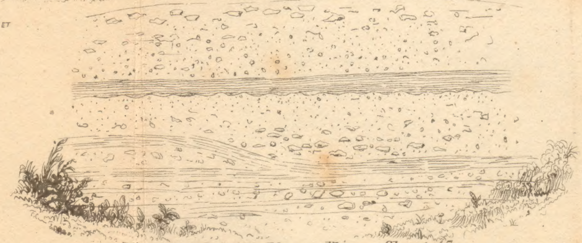


Fig. 5. Ph. of Ballyscullion. Sheet 47.

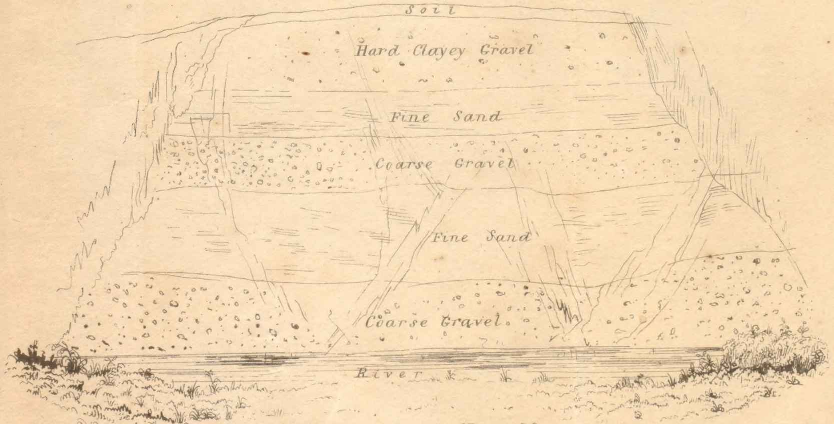


Fig. 4. Ph. of Banagher. Sheet 30.

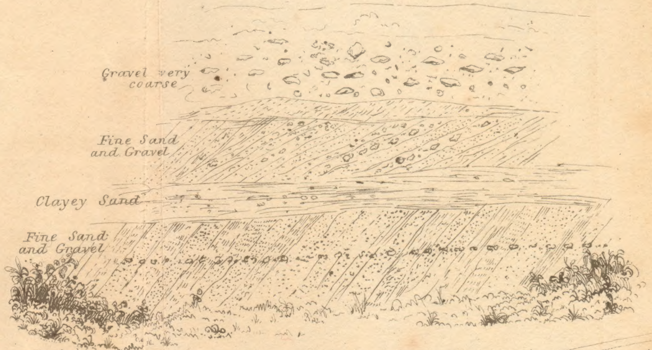


Fig. 6. Ph. of Magherafelt. Sheet 42.

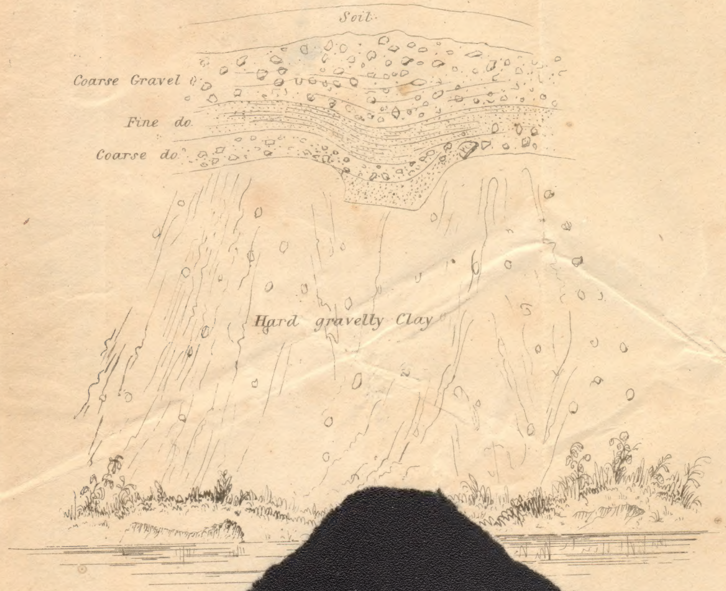


Fig. 7 [illegible]

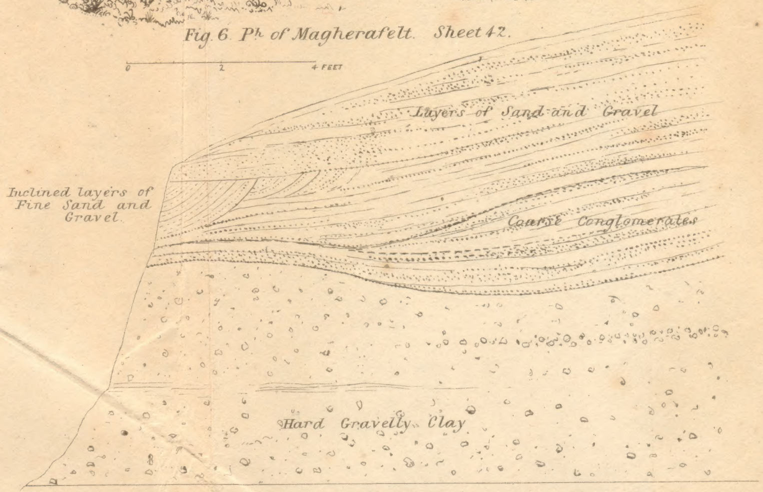

Layers of Sand and Gravel
Inclined layers of Fine Sand and Gravel
Coarse Conglomerates
Hard Gravelly Clay
0 10 20 30 40 FEET

Fig. 8. White Water, Ph. of Ballinascreen. Sheet 40.

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